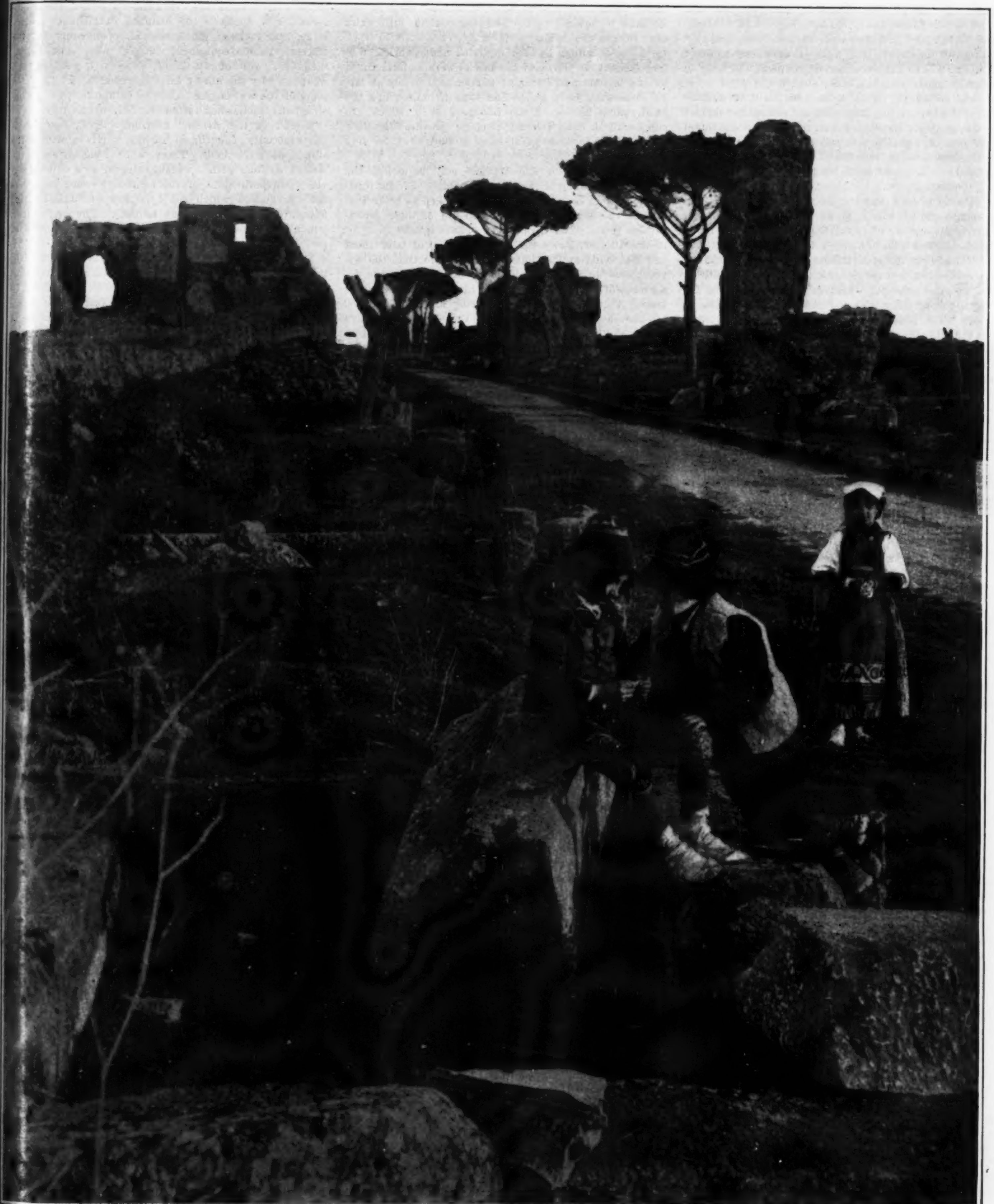
SCIENTIFIC AMERICAN SUPPLEMENT

VOLUME LXXIX NUMBER 2043

NEW YORK, FEBRUARY 27, 1915

10 CENTS A COPY $5.00 A YEAR



THE APPIAN WAY, NEAR ROME. A GREAT ROMAN TECHNICAL ACHIEVEMENT.—[See page 130.]

Roman Technics and Industry in Early Germany

A Commercial and Technical as well as a Political Conquest

It has been said that it was not love of conquest but economic necessity that led Rome to advance against the Germanic tribes which were constantly pushing southward. As these tribes were subdued Roman sway extended first to the line of the Rhine and the Main, and finally to the shores of the North Sea. The Romans owed the victory, it is claimed, to their superiority in the manufacture of weapons and tools and to their skill in the building of military roads, bridges, and fortifications. After the Germans had learned these arts, according to this theory, they were able not only to drive the Romans out of the conquered provinces, but soon to appear as masters on the other side of the Alps.

Cicero called the Alps a natural wall of defense against the barbarians, and when the campaigns against the Germanic tribes began the Roman legions found these mountain chains a troublesome obstacle. Hence, the Romans were driven to the building of roads over the mountains. The Roman roads, all of which started from the capital, have been divided into roads extending to Africa, Asia, the Iberian Peninsula, the Balkan Peninsula, and by way of Milan to Germany, Gaul, and Britain. In the era of its highest prosperity the roads of Rome were double the length of the equator. It was one of the principles of Roman road-building that a road connecting two places should be straight, without regard to the necessity which might thereby arise for bridges, the piercing of mountains, or the crossing of swamps. The roads had footpaths on each side, were from over thirteen feet to nearly twenty-three feet wide, and sloped toward the sides. The materials of the particular neighborhood were used as far as possible in their construction. There were nine roads across the Alps in the reign of Augustus. One lead over the Great St. Bernard (8,108 feet high) from Mediolanum (Milan) *via* Argentoratum (Strasburg) to Magontiacum (Mainz), and was only for pack-animals, not wagons. A broad wagon-road went over the Splügen to Bregenz and thence to Vindelicorum (Munich). The Romans seldom made tunnels, one of the few being that between Puteoli and Naples.

According to reports that have come down to us, Cæsar seems to have used acetic acid for loosening the rock in limestone mountains, the statement being "he burned away the rock." Livy's reference to this is explained by von Veltheim, thus: "Great piles of burning wood were set close to the rock and it was sought to direct the draft of air so that the flames played constantly against the rock, and when this was red hot or at least very hot and friable water was poured upon it, so that the sudden cooling might split it more thoroughly."

Some interesting statements respecting Roman methods of constructing roads, buildings, and fortifications in what is now the German Empire were made in a paper read last April before the District Engineering Association of Berg by Prof. Dr. Jakobi of Elberfeld and published in the *Zeitschrift des Vereines deutscher Ingenieure.* Prof. Jakobi said:

"From Mainz, which was a great storehouse for military equipments, fine roads ran to Cologne, Trier, Wiesbaden, and the fortress of Saalburg. The road from Mainz to Cologne was built on a dam 2 meters high, 8 meters broad below and 6 above. Other roads ran from Cologne to the mouth of the Weser. Corduroy or wooden roads were laid across the moors, and the remains of such a road were found by Haarmann, near Osnabrück, and given to the Deutsches Museum at Munich. This wooden road, about three meters broad, was somewhat like a railroad track. It consisted of two parallel longitudinal beams on which the cross blocks of oak rested."

The Romans preferred land travel to journeys by water; in going from Rome to Spain the long land route was chosen rather than the trip by sea. Consequently, the art of building bridges was highly developed. The mortar of lime and sand then ordinarily used could not be employed for the pillars of bridges, as it needed air for hardening. Pozzuolana earth and trass which set under water like cement were, therefore, used by the Romans in bridge work. The foundations still exist near Bingen of a bridge with eight arches built 70 B. C. In house-building, besides quarried stone, brick was largely used; in Germany the bricks were manufactured by the legions and bore the particular legion's stamp. In interesting contrast to the Roman houses are the small stone houses of the Lüneberg Moor which are supposedly of early Germanic origin. In these the floor and ceiling are made of slabs of stone over three feet thick.

The Rhine, Main, and Danube may be called the northern boundary of the Roman Empire. Strong fortifications were erected along this boundary as protection against the Germanic tribes. In front of these fortifications ran a ditch with heavy palisades, and in front of the ditch extended the Limes, a strip of land about 120 feet wide and stripped of timber so that the approach of an enemy could be seen. Through the researches of the German Imperial Limes Commission it is known that this protective clearing extended for 550 kilometers from Hönnigen on the Rhine eastward across the Taunus, reached its most northern point at Hainhaus, crossed the Main at Seligenstadt, and went on to the Danube by way of the Odenwald. There were entrances on the Limes at many spots to permit intercourse with neighbors. These entrance-gates were protected by square towers, generally a story and a half high. Traces of about nine hundred such towers have been found. The fortresses or castles lay about 250 meters behind the Limes, and the remains of some eighty of these fortresses have been discovered, the best known being Saalburg Castle, near Homburg-von-der-Höhe. Saalburg was built A. D. 11 and for nearly three centuries was one of Rome's most important strongholds on the Rhine. In 1868 a thorough investigation of the ruins was ordered and in 1896 the reconstruction of the Saalburg was begun, the plans being based on the remains and historical drawings. Prof. Jakobi describes the castle thus:

"The castle is a rectangle with rounded corners 222 meters long and 147 meters broad. The *Porta decumana*, on the side away from the foe, is 6 meters higher than the *Porta prætoria*, the entrance toward the foe. The encircling wall is about 750 meters long and 5 meters high. The Romans opened two quarries from which they obtained the quartzite blocks for the building. The lime came from Berkersheim-on-the-Nidda. The bricks were from the brickworks of the Twenty-second Legion at Nied-on-the-Main. No remains of the hoisting machinery used have been found, but Vitruvius has described such based on the pulley. The ditches before the *Porta decumana* were crossed by a bridge with a wooden railing. The *Porta decumana* had a tower on both sides, the upper story of the towers being united each with the other by a protected passageway. The 3-meter-wide walk along the wall, which was protected by a breast-high parapet, could be reached from this passageway."

The third of the fortresses toward the friendly side is said to have been called the *Retentura;* next came the *Latera prætoris*, the central portion; then the *Prætentura*, the section on the hostile side. The *Retentura* contained the *Quæstorium*, the business office of the battalion where the soldiers were paid. There were found here no less than one hundred and fifty styli, a great many writing-tablets, papyrus rolls, and ink-stands. The *Horreum* was a storeroom for provisions and held the stores of grain; in a dark part of it were kept the fresh and smoked meat and game. The *Prætorium* is a group of buildings 50 meters long and 40 meters broad through which runs the road connecting the two side-gates. It contains the commander's house, the store-room for equipments, the drill-hall, 442 square meters large, and incloses the *Atrim*, an open court for the officers. In the equipment chamber were found apparatus for war of all kinds, especially helmets and weapons. By the aid of existing remains and tradition some of the war-engines, such as catapults, were reconstructed, which when tested worked successfully.

"North of the *Atrim*," continues Prof. Jakobi, "is the sanctuary (*Sacellum*) of the garrison where the standards were kept. These were venerated by the Roman soldiers with a worship similar to a church service. On both sides of the sanctuary were chambers for the guards which could be heated. The heating apparatus was arranged as follows: The brick floor, which is covered with plaster, rests on stone pillars 0.7 meter high. Outside, protected by a projecting roof, is a sunken fire-hole in which charcoal is burned. The gases which pour out flow along under the flooring, which they slowly warm. They are then carried off by vertical clay pipes. An experimental test of the reconstructed heating apparatus gave excellent results. A reconstructed oven also proved to have been correctly made. As further protection against inclement weather, the rooms of the castle had glass windows. Judging from the remains of glassworks on the Feldberg in the Taunus, the glass used at the castle, where it was also blown, was a green soda-glass."

Much care was given to the supply of water both for the castle and the surrounding civil population. Wells were dug and, besides, water was brought from the neighboring mountain streams through hollowed tree-trunks or lead pipes. The remains of furnaces for baths found at Saalburg correspond to those known at Cologne and Pompeii. They are well constructed for their purpose and permit warm or cold water to be turned into the baths at pleasure. In the eighty wells of the civil settlement surrounding the fortress of Saalburg numerous tokens of a vanished civilization were found, such as hooks, rollers, coins, handles, buckets, and shoes. Among the shoes were sandals of wood and leather, low and high shoes, laced shoes, etc. The shoes were made of leather, tanned in the most various ways, from deerskin, goat, calf, and neat skins. Millstones for grinding grain were also found, some for handmills, some to be driven by draught-animals.

The soldiers belonging to the fortress in their free time worked at trades, but the main industrial activity was naturally in the civil settlement, where, beside Roman mechanics, tradesmen, and tavern keepers, there were also soldiers who had served their time. During the excavations the cellar of a tavern was uncovered and in it was found a large number of coins, drinking vessels, and bottles. The Saalburg Museum contains a collection of tools that have been dug up, as hammers, chisels, planes, knives, compasses, as well as what seem to be surgical instruments. The wrought iron and steel needed for weapons and tools were made directly from the ore.

Germans from the valleys of the Main, Lahn, and Rhine came to the fortress and settlements to barter skins, cattle, and game for tools, clothing, mirrors, enamel ornaments, glassware, etc. This contact with civilization taught them new ideas as to the conditions of life and led them to learn handicrafts for themselves.

Agricultural Fertilizers

With the cutting off of the potash supplies from Germany, whose rich deposits have been relied on by manufacturers of fertilizers throughout the world, people have been busily looking about for other sources for this necessary chemical. One of the first directions in which people have turned is to kelp, which is available in great quantities on our western coast, and several projects are on foot to utilize this apparently inexhaustible supply of raw material. There are, however, other sources from which potash may be obtained, and although no great quantities are to be expected in this direction, still in some localities the use of wood ashes might be considered with advantage.

Older people will remember the little inclosures attached to every farm and to many houses in the smaller towns where wood was used as a fuel, in which all of the wood ashes were carefully preserved. This formed the source of the potash used in soap-making, at the time when many farmers made their own soap; and many people spread the surplus on their land as a fertilizer. The most common custom, however, except in remote communities, was to sell these ashes to itinerant collectors, who traveled through the country in the interest of regular manufacturers of potash, and from these came the greater portion of the potash used in the earlier days of our country. Hardwood ash is much richer in potash salts than softwood ashes, and was the only kind that had a market value, although for direct application to the land any kind of ashes is better than none; and while there are few localities where wood is now used as a fuel in sufficient quantities to make the utilization of the ashes of importance, still this is one of the economies that it is as well not to lose sight of.

Besides wood ashes, those from cotton hulls are worthy of consideration in some places, as they are much richer both in potash and in phosphoric acid than the best wood ashes.

There is hardly a farm in the country where quantities of valuable fertilizing material is not constantly wasted as "trash," which is gotten out of the way in the most convenient way possible. Most of this is burned in some out-of-the-way spot and the ashes left where they lie, whereas the burning could as well have been done on cultivated land and the ashes profitably distributed. Much of this trash also contains valuable supplies of nitrogen that could easily be saved to the soil by a little forethought and with no extra labor. It is due to the neglect of these little things and thoughtless waste of matter right at hand that there are so many "worn out" farms in this country.

Biochemical Systems*

And Their Function in the Development of the Organism

By Prof. W. Bechterew, of the Imperial Academy of Petrograd

Until recently the differences between human races and individuals, and the differences between animal species, have been attributed to the influence of external factors, while the internal causes of these variations have been neglected. Yet, the importance of external factors in the process of natural selection, though great, is inferior to that of the internal causes of the variations which make the process possible. The latter are the biochemical processes of nutrition and growth.

In regard to plants this statement requires no elaboration, for it is well known that the forms and colors of leaves are affected by chemicals applied to the roots of plants. The question demands more profound study in the animal kingdom, where the processes of nutrition and growth are more complex.

The general influence of nutriment on development is well known, and numerous researches have established a correlation of the biochemical process with the growth and development of certain organs. Every organ pours its specific secretion into the blood and thus affects the entire organism.

The greatest influence is exerted by the so-called glands of internal secretion, including the thyroid, parathyroid, thymus, pineal, hypophysis, subgastric, adrenal, genital, and other glands. Some of these oppose each other. The secretions of the thyroid, adrenals, and hypophysis increase the formation of leucocytes and the elimination of organic salts, while the subgastric and parathyroid secretions produce the opposite effect.

Certain glands exert a specific action on saline exchanges. Injected extract of hypophysis diminishes elimination of phosphorous by the kidneys and increases its elimination by the bowels. Thyroidine increases elimination of phosphorus and calcium by the bowels, and of magnesium by the kidneys. Removal of the parathyroids is followed by increased elimination of calcium.

The nervous influences of the glands are equally various. In general, the glands that stimulate the central nervous system depress the sympathetic system, and conversely. The subgastric and parathyroids stimulate the central and depress the sympathetic system, while the adrenals, thyroid, and hypophysis act in the opposite way.

The glands exert a regulating influence on themselves and each other, through the sympathetic system which connects them. They also affect the blood vessels and the absolute and relative numbers of the various sorts of leucocytes.

The glands act on each other by means of secreted substances which Starling has named "hormones." As a general, but not invariable rule, each gland thus acts on only one other gland.

The antagonism between different glands is indicated by many clinical observations and results of experiment. The ovaries retard the pulse and the formation of bone, both of which are accelerated by the thyroid.

The ovaries are also antagonistic to the adrenals, hypophysis and bone marrow. Adrenaline and cholin, secreted respectively by the central and peripheral parts of the adrenals, antagonize each other. The correlation between the thyroid and the thymus is very evident. The thyroid acts in concert with the adrenals and in antagonism to the subgastric. Hypertrophy of the thyroid is accompanied by hypertrophy of the central part of the adrenals, and glycosuria is caused by the combined action of the increased secretions of both glands. An injection of adrenalin produces glycosuria in a normal dog, but not in a dog which has fasted three days after ablation of the thyroid, while the removal of the subgastric increases the glycosuria caused by subsequent injection of adrenalin. Similar antagonisms exist between the thyroid and hypophysis, and between the adrenals and liver.

The glands also influence the morphological variations of the entire organism. The removal of the thyroid from young animals produces a state of cretinism, with alteration of the skeleton and retardation of the process of ossification. Lesions of the hypophysis produce the diseases called acromegaly and gigantism. According to researches made in our laboratory, the immediate effect of ablation of the hypophysis is increased elimination of phosphorus and nitrogen. Other researches have shown that the secretions of the hypophysis influence the development of the skeleton, the reproductive function, and the innervation of the blood vessels, bladder, and intestines. Excessive secretion during growth leads to gigantism, excessive secretion after maturity causes acromegaly, while insufficient secretion produces excessive deposition of fat and atrophy of the genital glands.

An influence of the pineal gland upon the formation of the genital organs has recently been inferred from the very precocious and exaggerated development of those organs that follows lesions of the gland. The influence of the testicles on growth and the development of secondary sexual characters is well known, and is easily demonstrated by experiment. The effects of castration very early in life include a striking deficiency in hair and other cutaneous appendages, deficiency in fat, alterations in the throat and voice, changes in the color of plumage in birds, etc. These effects can be prevented by injecting an extract of testicles. The influence of the secretions of the liver upon the color of the skin has long been known by clinical observation.

We are compelled, therefore, to admit the existence in the organism of certain biochemical systems consisting of the activities of various glands. The formation of bone and muscle, for example, is promoted by the combined action of the thyroid and hypophysis, while this action is opposed by the ovaries. The development of cutaneous appendages, subcutaneous fat, the mammary glands and the larynx is affected by the genital glands and the thyroid. The coloration of the skin and its appendages is related to the activity of the solar plexus and the liver. Muscular strength is influenced by the genitals and adrenals. The development of the brain is proportional to that of the cortical layer of the adrenals, which secretes cholin. Finally, the formation of the genital organs is related directly to the activity of the hypophysis and, less directly, to that of the pineal gland.

Individual, sexual, and racial differences in man, and differences between animal species, are due chiefly to different combinations of the factors described above. The combination is determined partly by cross-breeding, and partly by external conditions.

The great and long recognized influence of crossing is probably due largely to a combination of glandular elements in the embryo and action during growth.

This view is supported by the fact that heredity presents, not a combination of all the characters of both parents, but a selection, which corresponds with the characteristic functions of certain glands. A striking example is furnished by secondary sexual characters, which are often so distinct that they might easily be taken for attributes of species. Yet they depend essentially on the presence of testicles or of ovaries. Other examples are furnished by gigantism and nanism (dwarfishness) which are sometimes hereditary. These peculiarities are caused respectively by excessive or deficient functional activity of the hypophysis and thyroid. In both cases the head is out of proportion to the body. Giants' heads are usually too small and dwarfs' heads are too large. This fact is very significant, because the occiput is formed from connective tissue and not from cartilage, the development of which is determined by the activity of the glands in question. If gigantism and nanism were caused by more general factors all giants would have large heads and all dwarfs would have small heads.

Throughout the animal kingdom, but especially in birds, the lively and quarrelsome disposition of the male, which is manifestly due to the action of the sexual glands, is associated with peculiarities in the development and color of the plumage or other cutaneous appendages, and both phenomena are exhibited most conspicuously in the breeding season.

These facts prove that the differences between species, races and individuals, including differences in temperament and mental character, are conditioned largely by the influence of glandular secretions.

The activity of the glands, however, is affected by external influences, sunshine, humidity, food, and the general conditions of life. Certain butterflies, long regarded as distinct species, have been found to be spring, summer, and autumn varieties. Many observations prove that animals are altered in size and other peculiarities by changes in climate and other external conditions. That these alterations are caused by the agency of the glands is proved by the prevalence of cretinism, nanism, and goiter in certain districts where the development and activity of the thyroid are affected by external factors which have not yet been identified. These are pathological cases, but they differ only in degree from simple morphological variations. In a mountain district in Siberia malformations of the skeleton are so common that the natives do not regard them as abnormal. The cases that I have examined show a shortening of tubular bones, caused by thyroid insufficiency in the period of growth.

It is more important to know if the glandular changes caused by external factors can be transmitted to posterity, for such transmission would explain the evolution of races and species. Here we encounter the great problem of the inheritance of acquired character, which Darwin admitted and which the neo-Darwinians, headed by Weissmann, deny. According to Weissmann's germ-plasm theory, the organism neither transmits nor acquires anything more than a predisposition, the so-called acquired characters being merely local or general alterations produced by external factors. Many modern biologists, however, agree with Darwin.

The problem has been discussed most clearly by Yves Delage, who distinguishes three classes of acquired characters: mutilations, which are never transmitted; effects of use or disuse, the transmission of which has been neither proved nor disproved; and effects of conditions of life. The third class includes pathological conditions, such as inflammations and epilepsy, the transmission of which was apparently proved by Brown-Séquard, whose results have been confirmed by some later experimenters and contradicted by others. Delage distinguishes as certainly hereditary all diatheses that affect the reproductive organs and all infections (including tuberculosis) that can be transmitted with the sexual products. The transmissibility of other diseases is difficult to prove, owing to the uncertainty, in many cases, whether they are congenital or have been acquired after birth. In regard to other effects of external conditions Delage himself is in doubt, owing to the discordance of the observations.

Standfuss found that changes in color produced in certain butterflies by temperature were transmitted to their descendants. From some butterflies (Vanessa), which changed color under the influence of a very low temperature (23 deg. Fahr.) he obtained 43 descendants of the first generation which showed the same change in color. Of the eight pairs of these descendants that were mated one produced a single specimen that preserved the acquired coloration and three that deviated from the normal in the direction of that coloration. The progeny of the other seven pairs was normal. Fischer found that changes produced in the color and even in the form of butterflies' wings, by exposing pupæ to a temperature of 14 deg. Cent. were reproduced in 10 per cent of their progeny, and Pictet has obtained similar results with alterations produced in butterflies by abnormal diet.

By exposure to abnormal temperatures Kammerer caused the normally viviparous black salamander to lay eggs and the normally oviparous spotted salamander to bear living young, and these changes in habit were transmitted to the progeny. A curious change of instinct, artificially induced in a species of frog, was similarly transmitted.

Weissmann explains these results by the influence of external factors on the germ plasm, but, in view of the facts described earlier in this article, I am inclined to regard the direct action of those factors as being exerted on the glandular secretions, which may, in turn, affect the germ plasm. At all events, the transmission of certain acquired characters appears to be settled.

This makes it possible to free the theory of natural selection from its great blemish—the element of chance. It has always been repugnant to meet, in a theory of rigorous causality, the hypothesis of accidental variations which became fixed because they proved useful to the species. What is the origin, the cause, of these variations? It seems insufficient to regard them as results of chance. With the recognition of the part which the glandular system plays in the organism we become aware of an interacting system of physico-chemical forces in which nothing is left to chance. The variations of equilibrium of these forces under the influence of external factors determine individual differences quite definitely.

Little is yet known of the nature of this equilibrium, and its variations induced by external conditions. In general we know that abnormal glandular activity causes the prevalence of goiter and nanism in the Swiss, Ural, and Caucasus mountains, and in the marshes of the Volga. A more profound study of the etiology of these maladies, and of cretinism, myxoedema, and Basedow's disease, will ultimately furnish an explanation of the internal causes that regulate the development of organisms.

*An abstract of an article in *Revue Générale des Sciences pures et appliquées.*

Oxy-Acetylene Welding

How to Make a Complete Oxy-Acetylene Welding Outfit

By A. H. Waychoff

The outfit here described was made complete by the writer, who felt the need of an oxy-acetylene welding outfit yet was unable to buy one, owing to the high prices charged by the manufacturers for these outfits. After considerable experimenting, and the construction of several devices I finally was able to make this outfit at a very small expense in comparison with what they generally cost.

Get a new or second hand 50-gallon range boiler *A* and plug up the hole in the bottom. Then as close to the bottom as possible cut out a hole 3 inches across *B*, and fit it with a hand hole plate and yoke, as shown. This is for the purpose of cleaning out the sediment which is formed by the carbide dropping into the water. In the hole *C*, which is already in the boiler, screw a short nipple, an elbow, and a short length of ¾-inch pipe, and on the end of this pipe place a globe valve with a small funnel soldered on. The top of the funnel should come about half way up the boiler. This is for the purpose of filling the boiler to the required height with water. Next get a piece of 10-inch pipe *D* for the carbide tank, about 12 inches long and with a flange screwed on each end. Cut out a hole in the top of the boiler 10 inches in diameter, and rivet the carbide tank on, as shown in Fig. 1, using a lead gasket between the flange and the top of the boiler at *E* to make a perfectly gas tight joint. Make a hopper *F* of 20 gage galvanized sheet iron, which will just fit inside of the carbide tank *D*, the bottom part of the hopper at *G* being 3 inches in diameter. Fasten the hopper to the inside of the tank as shown by means of about four small stove bolts. Next get a cover plate *H* to fit the top flange of the carbide tank *D*, and tap out at one side for a 2-inch plug *I* for filling the carbide tank with fresh material. Drill another hole in the center of the head for the feed rod *J* to work through.

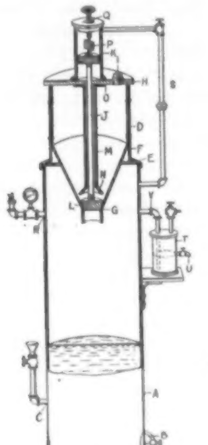


Fig. 1.—Acetylene generator.

An old gasoline engine cylinder *K*, with piston, is mounted on the top of the plate *H* as shown. The feed rod *J* is made of a piece of 5/8-inch steel rod. The valve *L* is a piece of hard wood, 1 inch thick, and conical shape, so as to fit into the bottom of the hopper *G* when closed. Connect the feed rod up as shown, one end to the valve *L*, the other to the piston in the cylinder *K*. A galvanized sheet iron tube 1-inch inside diameter *M*, having a flange soldered on at the top at *O*, is fastened to the top plate *H* by machine screws, and at the bottom of the tube a funnel shaped piece *N* should be soldered on, which covers the valve *L* so the carbide cannot get on the top of it. The space between this valve cover *N*, and the walls of the hopper should be about one half inch. This allows the carbide to fall through when the valve is open. Next tap out for a screw-eye in the top of the piston, to which is fastened a closed coil spring *P*, and a hole is drilled and tapped through the cylinder head for a hand screw *Q*, which is fastened to the spring as shown. At *R* mount a gage and safety valve. The gage can be an ordinary steam gage, registering at least 50 pounds pressure, at *S* fit a half-inch pipe, which should be connected up with the cylinder *K* as shown. Next get a piece of 4-inch gas pipe 12 inches long *T* for the flash back arrester, and fit a cover on each end, and tap out 6 inches from the top for a small drain cock *U*. Then run a pipe *V* from the tank through the top plate, and down within 1 inch of the bottom of the arrester as shown by the dotted lines. Screw in an outlet pipe with an angle valve as shown, and a short piece of pipe having grooves cut in it to which the hose to the torch may be clamped on securely.

Before operating this generator, go all over it to see that all the joints and connections are gas-tight. This may be done by putting soapy water on all the joints while there is air or other pressure in the generator. If all connections are tight, fill the generator with water up to the level of the funnel through pipe *C* and close the valve. Set the safety valve so it will pop at about 30 pounds pressure. Then loosen the spring *P* as much as possible by screwing down the hand screw *Q*. Remove the filling plug *I* and fill the hopper with one half inch lumps calcium carbide. Put the plug back and close the outlet valve on the flashback arrester. Gradually tighten the spring *P* by means of the hand wheel *Q* which draws up the piston and opens the valve allowing some carbide to fall into the water. This generates the acetylene gas, the pressure of which, acting through the pipe *S*, forces the piston *K* down and closes the valve *L*. By a few experiments the spring can be adjusted to the proper tension, so that the pressure on the piston will automatically close the valve as soon as 7 pounds pressure is reached in the generator. Seven pounds is about the best working pressure for all around purposes, but for higher or lower pressures a slight turn of the hand wheel will give anything desired. The flashback arrester should be kept full of water up to the drain cock.

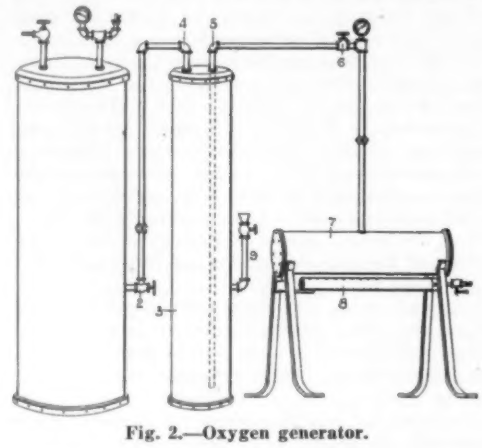


Fig. 2.—Oxygen generator.

The oxygen generator, shown in Fig. 2, is a simple and easily made apparatus, and needs very little description. Get a 50-gallon range boiler, plug up the bottom hole and mount a pressure gage and safety valve on one of the holes at the top as shown. In the other hole fit a piece of half-inch pipe with an angle valve, also a short piece of half-inch pipe with grooves for attaching the hose that conveys the oxygen gas to the torch. At the hole in the side of the boiler put a nipple and angle valve *2*.

Get a smaller tank—the 30-gallon size—*3* being about right, and pipe up to the large tank as shown at *4*. A piece of pipe ½-inch *5* is run down inside tank *3* to within 4 inches of the bottom as shown by the dotted lines.

To make the retort *7* get a piece of iron pipe 5 inches in diameter and 18 inches long with a flange and head for each end. Mount this on suitable legs and fit a gas or gasoline burner 8 below as shown. If copper pipe can be had for making the retort it is much better, but iron is very satisfactory. The small tank *3*, commonly known as the scrubber, should have a filling pipe 9 so that it can be filled with water within 18 inches of the top. The retort *7* and scrubber *3* are connected up as shown, a valve any gage being fitted at *6*, which should now be tested out carefully for leaks at all joints before putting into operation.

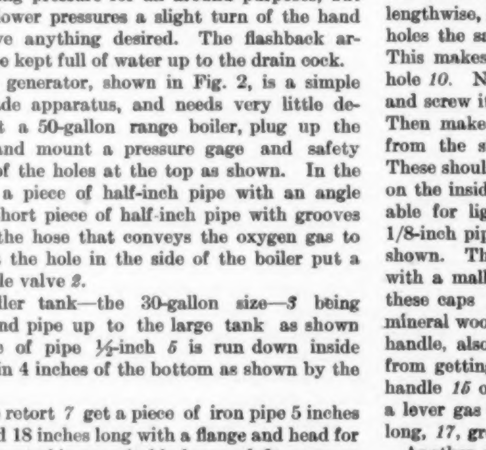


Fig. 3.—The blowpipe.

To use this generator make a half round tray of thin sheet iron that will just fit inside of the retort, and fill it with a mixture composed of one part manganese dioxide and three parts potassium chlorate. Put the tray inside of the retort and bolt the end plates in place and light the burner. See that the scrubber 3 is filled with water and that the valves *2* and *6* are open. Leave the fire burning pretty strong until about 30 pounds pressure is obtained, then the fire may be adjusted so as to generate the oxygen as fast as it is used. From 15 to 30 pounds is about the best working pressure, according to the kind of work.

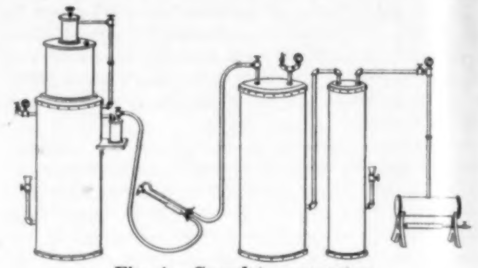


Fig. 4.—Complete apparatus.

When the chemicals in the retort are about exhausted a good way to tell if the retort needs a new charge is to close for a few seconds valve *6*. If the pressure rises on the pressure gage at *6* gas is still being formed and more chemicals are not needed. If a sheet iron hood be made to fit over the retort to conform the heat, it is better.

Care should be taken with the potassium chlorate to keep it in a metal container, so nothing can get mixed with it as an explosive compound might easily be formed.

The complete torch or blowpipe is shown in Fig 3. For the head of the torch get a 1/8-inch angle valve, *9*, and remove the hand wheel and packing nut. Take out the valve stem and drill a 1/32-inch hole through it lengthwise, as shown in Fig. 3, *10*; also at *11* drill two holes the same size crosswise intersecting the hole *10*. This makes four holes or inlets at right angles to the hole *10*. Next saw off the valve stem as shown at *12* and screw it into the valve so it comes tight on its seat. Then make several tips like *13*, Fig. 3, having holes from the size of a needle to 1/32-inch in diameter. These should have threads cut on them to fit the threads on the inside of the valve bonnet, and are interchangeable for light or heavy work. Next screw a piece of 1/8-inch pipe, *14*, Fig. 3, 8 inches long into the head as shown. Then get a piece of 3/4-inch pipe 6 inches long with a malleable cap on each end *15*, and drill and tap these caps for 1/8-inch pipe. Fill the pipe *15* with mineral wool, packing it lightly. This pipe serves as a handle, also as a flashback arrester, preventing any flame from getting into the supply hose. Screw this pipe or handle *15* onto *14*, as shown, and on its other end fit a lever gas cock, *16*, and a piece of pipe about 4 inches long, *17*, grooved to clamp the hose to.

Another piece of pipe, *18*, 1/8-inch in diameter and 15 inches long is bent at one end in a gooseneck, where it screws into the head, *9*; the gas cock, *16*, and connecting pipe, *18*, are fitted at the other end.

In operation the oxygen comes into the torch through the gooseneck pipe, *18*, at a pressure of two to three times that of the acetylene which comes through the pipe, *14*. The oxygen, passing through the hole *10* Fig. 3, at a greater velocity than the acetylene sucks the acetylene gas through the four holes, *11*, Fig. 3, and the two gases mix, forming a combustible mixture at the tip. The torch is connected up with the oxygen and acetylene generators as shown in Fig. 4 by means of two pieces of high pressure hose, each about 10 feet long. Be sure to attach the hose from the acetylene generators to the pipe, *14*, Fig. 3, and the oxygen to pipe *18*. Then turn on the the acetylene gas and light it at the tip allowing it to burn for a few seconds, then gradually turn on the oxygen gas until the flame takes a sort of a bluish green color with a distinct white cone shape flame in the center. If the torch smokes, the amount of acetylene should be reduced.

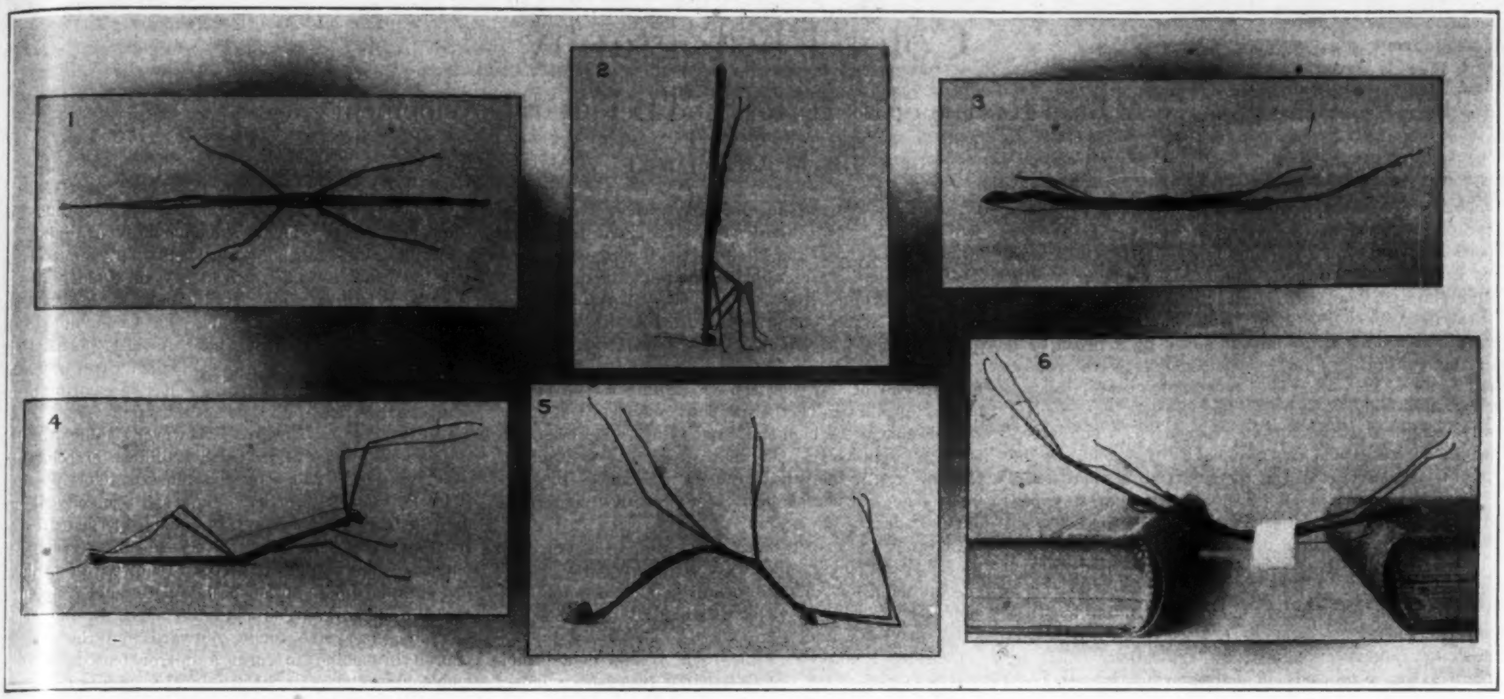


Fig. 1.—Normal resting attitude of the insect carausius. Fig. 2.—Standing on its head. Fig 3.—Extended on its back. Fig. 4.—Nautis or seahorse-like pose. Fig. 5.—The wrestling bridge, body bent and supported by a small stone. Fig. 6.—Insect as a bridge between two books, its body weighted by paper slips.

Catalepsy in insects.

A Physiological Puzzle*

Hypnosis of Animals and Insects and Comparisons With Human Beings

What the magicians did in ancient days before Pharaoh in the way of turning sticks into snakes has often been done since, or its converse of turning snake into stick, but it remains in great measure a physiological puzzle. If the cobra in its threatening attitude be deftly caught behind the head and gently pressed, it soon becomes stiff, and will remain so for a considerable time, either coiled up or drawn out straight. It has passed into the strange state of animal hypnosis. In 1646 the Jesuit father, Athanasius Kircher, described the famous experiment, "de imaginatione gallinæ." He laid a hen on the table, held it firmly for a little, and drew a chalk line in front of its eyes, with the result that it remained as if in catalepsy. Czermak showed in 1872-1873 that this could be done with many birds, and that the chalk line was quite unnecessary. The veteran entomologist, Fabre, tells us that he and his school companions used to put a whole flock of turkeys to sleep with their heads tucked under their wings. Animal hypnosis can also be induced in mammals (guinea-pig, rabbit, mouse, squirrel, bat, dog, cat), and this is usually effected experimentally by fastening them to a board and turning this suddenly upside down. Frogs are readily susceptible, and newts will also submit.

In backboned animals the state of immobility is scarcely known except in artificial conditions, and can scarcely be of much importance in life. It is otherwise, however, when we pass to the analogous "death-feigning" or catalepsy in certain beetles, water bugs, stick-insects, and spiders. The immobility occurs in natural conditions, and it seems often to save the life. The case of the female Galeodes is of special interest, since the more than recalcitrant female passes into a convenient hypnosis when she is suddenly seized by the weaker male. This may be induced artificially in the sexually mature female by gripping her suddenly in the dorsal region of the abdomen with a pair of fine forceps and raising her from the ground. She remains quite passive until she is restored to earth. It is very interesting to note that older females, who have paired, do not pass into catalepsy, but turn fiercely on the forceps. In the same connection it is worth recalling that when we lift a shore-crab, holding the shield between finger and thumb, and wave it in the air, it becomes immobile, but the two sexes dispose their limbs in different ways, the female bending them in over the abdomen, as if protecting the eggs. The familiar case of the fresh-water crayfish is interesting, because the creature does not pass suddenly into hypnosis, but usually resists for a considerable time. It may be fixed in any position of equilibrium—on its head, on its back, or even in its normal pose. The stick-insect, Dixippus, which feeds at night, normally assumes its protective immobile attitude under the stimulus of light, but a mechanical stimulus also serves. Schmidt has recently shown that the insect can be fixed in any grotesque attitude for hours on end. It has been shown that the transition from one state to the other can in this creature be effected almost in a moment.

In a case like the stick-insect we cannot but regard the cataleptic habit as of protective value; it adds to the safety which the protective form and the protective color also help to secure. The creature behaves as if it knew, for it almost always disposes itself parallel to the twig to which it is attached. Schleip also points out that when it lets go on being touched, the elongated, straight disposition of the appendages makes it easier for it to slip down among the twigs. In Galeodes, as we have noted, the sudden passivity of the female is of importance in reproduction, and a similar phenomenon has been observed in the female octopus. In many cases, however, it seems quite impossible to maintain that the catalepsy is protective to all. Thus, Fabre notes that *Scarites buparius*, one of the large ground-beetles, which a shake sends into a lasting catalepsy, is voracious, well-armored, nocturnal, and unpalatable. What has it to do with "death-feigning?" Cases of this sort suggest that the cataleptic tendency may be simply a concomitant of a certain type of nervous constitution, and that it is only occasionally turned to advantage.

According to Mangold, the characteristics of human hypnosis are: that it is a sleep-like state, induced by suggestion; that it implies a rapport between the hypnotizer and the patient, and an increased amenability to suggestion; that it involves an inhibited power of locomotion and of "righting" the body, a change in muscular tonus—from initial increase to somewhat sudden decrease—and a change in sensitiveness which may amount to anæsthesia and analgesia. Suggestion is a physically conditioned effect, for which the physiological stimulus seems to be inadequate. Little is known in regard to the hypnosis of the highest animals, like dogs and cats, the amenability of which to human influence is well known, but in ordinary cases it may be concluded, according to Mangold, that animal hypnosis differs from man's in the absence of the suggestion, the rapport, and the deeper stages. It may be induced in animals without a cerebrum, which indicates that the psychological factor is unimportant. Physiologically considered, however, the more typical forms of animal hypnosis must be ranked beside human hypnosis and studied in this light.

The resemblances are many. The sleep-like state is induced in man by suggestion or psychical inhibition, in animals by mechanical inhibition, but in both cases sensory stimuli may assist. These stimuli may be optic (fixing the gaze on some object), or tactile (stroking the skin), or otherwise. Sometimes an absence of wonted stimuli may induce the state, as in the case of absolute silence. The awakening may be brought about by sounds, shaking, currents of air, or electric shocks; or it may occur spontaneously. There is a great specific and individual diversity in susceptibility; the easier the inducing of the hypnosis, the deeper and more lasting it is. The muscular tonus changes characteristically (now great stiffness and again "waxy flexibility"); resistance to fatigue is increased. Reflexes are to some extent affected by the altered tonus. Sensitiveness to touch and to pain may be greatly lessened, and operations may be performed during hypnosis. But the senses remain awake, and, except in the deeper phases in man, memory partly persists. Anemic symptoms are sometimes observed, but there is no regular alteration in the every-day functions, such as the beating of the heart or the respiratory movements. Since animal and human hypnoses agree in all these respects, Mangold has confidence in his thesis that they are thoroughly analogous phenomena.

Finally, in his interesting study, he proposes a classification:

1. Experimental hypnosis induced by psychical inhibition (suggestion hypothesis): (*a*) in man, and (*b*) perhaps in some of the highest mammals;

2. Experimental hypnosis induced by mechanical inhibition: (*c*) in mammals, birds, reptiles, and amphibians, and (*d*) in crustaceans and insects;

3. Natural hypnosis induced by "biological" stimuli: (*e*) death-feigning in crustaceans and insects, and (*f*) catalepsy in stick-insects.

* "Hypnose und Katalepsie bei Tieren im Vergleich zur menschlichen Hypnose." By Ernst Mangold. From *Nature*.

Reinforced Concrete Aqueduct

At Borgone, Italy, is a good example of an aqueduct, or rather flume mounted upon pillar supports, the whole being built in reinforced concrete on the Hennebique system. The aqueduct runs through open flat country, and is about 4,650 feet in length. In this way the whole structure is of solid build and is likely to withstand against deterioration longer than the usual kinds. Square pillars on both sides uphold the flume part, these being spaced at frequent intervals.

Glass Surfaced Roads

It is reported that an experiment is being made with a material that heretofore has been a waste product of glass factories for road making. This is a thick syrupy liquid that hardens when exposed to the atmosphere, forming a substance that somewhat resembles glass. A quantity of this material is said to have been mixed with crushed stone and used to surface a stretch of highway in Illinois, forming a surface that is as smooth as concrete. How this surface will stand up under weather and wear will be watched with interest.

Color Photography*

A Brief Review of Its History and Details of Development

By M. C. Rypinski

LIGHT, according to the undulatory theory, is a sensation produced on the retina of the eye by a wave motion of the ether, all light traveling with the same velocity, the difference in color sensation being due to differences in wave-length and frequency.

Daylight, or white light, is a combination of color sensations and may be broken up as by a prism or a diffraction grating into its component spectral colors, red, orange, yellow, green, blue, indigo and violet.

Of these color sensations the red has the greatest wave-length and the lowest frequency. The wave-length decreases and the frequency correspondingly increases as the violet end of the spectrum is approached.

Beyond the red is an invisible portion of the spectrum, the infra-red, and correspondingly beyond the violet there is the invisible ultro-violet, both of which are characterized by their chemical action upon light sensitive substances.

When rays of light encounter an object they are affected so far as color is concerned in two ways: first, by reflection; second, by absorption. That is, there exists a property in matter which causes a reflection from its boundary surfaces of rays of certain wave-lengths and frequencies, and absorption in its mass of rays of certain other wave-lengths and frequencies. All other rays pass uninterruptedly through its mass.

An opaque object is one which reflects or absorbs all light falling upon it. A transparent or translucent object, on the contrary, allows some light to pass through more or less unchanged. For example, a blue blotter has an opaque blue appearance under ordinary white light because it absorbs mainly red and green and reflects mainly blue, transmitting no light; in red or green light it would appear quite black. A pane of clear window glass transmits all the primaries, red, green and blue, absorbing practically no light; white light therefore entering on one side emerges unchanged on the other. Cobalt glass looks blue by transmitted white light because it absorbs red and green, leaving the blue to emerge practically unchanged. An object, due to its particular reflective and absorptive properties, may, therefore, have a very different appearance when viewed by transmitted light as compared with reflected light, and its appearance will of course vary with the color of the light source.

Another variable is the color sensitiveness of the human eye. The normal eye sees all colors, but about four per cent of all individuals are color-blind and lack the power to distinguish color in certain parts of the spectrum, generally the red end. In rare cases no color sensation exists at all, all objects appearing white or gray in tone.[1]

Clerk Maxwell has shown that all color combinations may be reproduced by a mixture of not more than three primary colors, red, green and blue.

Painters and printers are accustomed to regard red, yellow and blue as the three primaries, but this is due to their working with the subtractive method of color combination, where colors are laid one on top of another so that the resultant color is the original or light source color, less all of the colors which the various color layers have the property of absorbing.

In addition to the subtractive method of color combination, there is the additive method by which the final net result is the sum of all the color components used.

While most painters use the subtractive method, there is a school of painting in which the color is laid on in the form of little dots arranged side by side. This additive process gets its color combination from the inability of the eye to distinguish minute objects distinctly at a distance, the dots merging and forming a combination image of a color resultant which is the sum of all the colors of adjacent dots.

Another characteristic of colored light which plays an important part in color photography is the difference in its action on the retina and its chemical effect upon a photographic plate.

It is required of a photographic image that it shall duplicate in proper light relation the object as seen by the eye; however, the ordinary plate or film emulsion is insensitive to the infra-red and yellow portions of the spectrum, fairly sensitive to the green, quite sensitive to the blue and highly sensitive to the ultra-violet portion. An object therefore illuminated by the uninterrupted light of a bright portion of sky (which is largely composed of ultra-violet) will show more contrast between lights and shadows in the photographic image than actually exists to the eye. Also the red end of the spectrum (according to the retinal image) appears to be the brightest, while in the photographic image the blue end appears to be the brightest. It is a well-known fact that when one wears dark blue or green, the studio camera reproduces them as light shades, whereas dark red or yellow appear as dark shades.

In order to correct these difficulties, it is therefore necessary to find some way of making the photographic emulsion; first, insensitive to ultra-violet; second, less sensitive to violet and blue; third, more sensitive to yellow and red.

Considered additively, the color yellow is a combination of red and green; so that a transparent object which appears yellow by transmitted light is one which absorbs violet and blue and transmits red and green. It is obvious, therefore, that the first two of the above-mentioned requirements may be satisfied if the ultra-violet be eliminated and the violet and blue subdued by interposing between the emulsion and object a yellow transparent filter of just the right hue to transmit the amount of blue necessary to effect a balance between its visual and photographic images.

The sensitiveness of the emulsion to yellow and red can be increased by utilizing the comparatively recent discovery that certain dyes when mixed with the emulsion render it more sensitive to the yellow portion of the spectrum. Others increase the sensitiveness into the red end.

Plates or films rendered sensitive to the yellow as well as to the blue and green portions of the spectrum are termed isochromatic or orthochromatic, while those which are sensitive throughout the entire spectrum are termed panchromatic.

Curiously enough, a panchromatic plate is least sensitive to that portion of the spectrum to which the eye is most sensitive, that is, the yellow-green, so that unlike ordinary plates which must be developed in a light of low luminosity to the eye (red), a yellow-green dark-room light of good luminosity may be used.

It may be interesting to now briefly review some of the more important steps in the development of our subject. The earliest experiments were conducted by Becquerel, Seebeck and others, commencing about 1810, and were confined to what are termed direct methods of producing photographs in color. The indirect methods had not then been thought of. By direct methods I mean those in which the light sensitive surface directly takes on the color of the light to which it is exposed. The indirect methods contemplate the production of several pictures which are independently colored and then superposed to give the final results.

These early experimenters utilized certain light sensitive silver salts which when exposed to colored light took on in a greater or lesser degree the colors falling upon them; this appearance, however, was not permanent, as the colors soon faded. In 1868 this phenomenon was explained for the first time by Zenker on the theory of the production of stationary light waves in the silver emulsion by interference of the impinging and reflected light rays.

About the same time it was discovered that many pigment colors were sensitive to light, becoming bleached through its action. Wiener, in investigating this phenomenon, determined that a light sensitive substance can be altered only by those colored rays which the substance absorbs; hence red light would have no effect on red, but would bleach out blue and green; green no effect on green, but would bleach out blue and red, etc.

If, therefore, a light sensitive surface made up of fugitive dyes of the three primary colors is prepared and exposed under a colored transparency, a color print in duplicate of the transparency will be obtained. This theory forms the basis of some of the more important development work now going forward, and it is very probable that it will lead to a satisfactory solution of the problem so far as paper prints are concerned. Thus far, however, the "utocolor" paper invented by Dr. Smith is the only process based on this phenomenon which is commercially available.

In the course of his experiments Dr. Smith found that certain dyes had a tendency to wander from a coating of one medium to another, as for example, from gelatine to collodion and *vice versa*, due to the affinity which acid dyes exhibit towards gelatine and basic dyes exhibit towards collodion. He was able thereby to greatly simplify the selective coloring of his emulsion layers.

Utocolor paper involves, however, inherent limitations as to time of printing, brilliance of color, etc., which makes it still somewhat unsatisfactory.

In 1891 Prof. Lippman confirmed Zenker's theory, by evolving a direct process producing permanent color transparencies and due entirely to interference phenomena. The Lippman process requires an ordinary photographic plate in a special plate holder arranged to hold mercury. The plate is placed in the holder with its glass side facing outward and the mercury poured in behind to form a mirror backing for the emulsion. The plate holder is of course so designed as to prevent any leakage of the mercury. On exposure in the camera the impinging light rays strike the glass plate first, then pass through the emulsion and finally arrive at the mercury mirror surface, being then reflected back through the emulsion retarded in phase angle so that interference with following impinging rays takes place. This interference creates stationary light planes of maximum and minimum intensity throughout the emulsion and parallel to the emulsion surface, and of course affects the silver in the emulsion in maximum amount at planes of maximum intensity, and in minimum amount at planes of minimum intensity. After development these planes of reduced silver operate selectively on incident white light so that when viewed along the angle of reflected rays the original picture in its natural colors becomes visible. This process, however, while capable of very beautiful results, is of scientific interest mainly and very few workers have been able to produce satisfactory plates with it.

It is now in order to mention the work done along lines which form the basis of our successful present-day processes. In 1868 Louis Ducos du Hauron, utilizing the principle laid down by Clerk Maxwell, discovered the "Three-Color Filter Process." This was an indirect additive process and was independently discovered by two other investigators, Charles Cros and Frederick Ives. It consisted in taking three consecutive negatives of the colored object to be photographed, each taken through a differently colored filter so as to selectively separate on each of the three negatives a primary color component of the original object. For example, one negative would be taken through a red filter which would allow only the red rays from the object to pass through and affect its negative. The second negative would be taken through a green filter, allowing only the green rays to affect its negative. The third negative would be taken through a blue filter, allowing only the blue rays to affect its negative.

Lantern slide positives of these three negatives would then be made and by means of a triple projection lantern the three images from the three slides would be superposed upon each other on the screen, after interposing between each positive and the screen its primary color filters as used in making the corresponding negatives. Each of these three superposed images would have therefore its own primary coloring and they would resolve into a combination image revealing the object in its original colors.

Ives in 1888 showed that the taking filters must collectively transmit all the rays of the spectrum of white light, while the viewing or reproducing filters need transmit only narrow bands of the spectrum, representing the three primary colors.

In addition to this additive method of reproducing the original object by means of superposed colored light images, it was shown that the reproduction could be made indirectly and subtractively by superposing prints from the three negatives upon each other. These prints must be very thin and the medium holding the image must be very transparent. They must also be individually dyed to their proper color before superposing. Further, they must not be dyed with a color the same as that of the corresponding taking filter, as in the additive process just referred to, but must be dyed with the corresponding complementary colors

* A lecture given at the eighth annual convention of the Illuminating Engineering Society, Cleveland, O., September 21st-24th, 1914.

[1] For further data relative to the eye see papers by Dr. H. H. Turner, p. 79, and by Dr. N. M. Black, p. 425, vol. ix, *Trans.* I. E. S.

For example, the positive printed from the red filter negative is colored with a blue-green (cyan blue) dye; that from the green filter negative with a blue-red (magenta) dye, and that from the blue filter with a red-green (yellow) dye.

The reason for this will be evident if we consider that here we are not dealing with overlapping lights, but with overlapping opacities in which each overlapping opacity or print absorbs part of the light transmitted by the other. To make this still clearer, consider an actual case, the reproduction say of a blue blotter. One would first take three negatives, red filter, green filter and blue filter. The red and green filters absorbing all blue rays would not show any image on their negatives, coming out transparent, while on the blue filter negative would be the well defined image of the blotter, more or less opaque in the high lights and transparent in the shadows.

On making positives for the additive or projection process, the red and green filter positives would come out opaque and the blue filter positive would show the image of the blotter transparent in the high lights and more or less opaque in the shadows.

On projecting the three positives through their respective reproduction filters, red, green and blue, no light would pass through the opaque red and green positives, while the blue positive would project a blue image of the blotter on the screen, brightly blue in the high lights, darkly blue in the shadows, thereby producing the desired effect.

With the subtractive process, as in the additive process, the positives from the red and green filter negatives would be opaque and from the blue filter negative would show a well defined image transparent in the high lights; more or less opaque in the shadows.

On dyeing, the prints from the red and green filter negatives would take up great quantities of their respective cyan blue and magenta dyes. The prints from the blue filter negative would take up a small amount of yellow dye in the high lights and more of it in the shadows.

When superposed therefore, and examined by ordinary white light, the overlapping cyan blue and magenta dyed prints would absorb the red and green, but not the blue components of the white light; the light parts of the yellow dyed print would absorb the blue falling upon it only slightly, giving a fairly bright blue reflection for the high lights, while the dark parts would absorb a greater proportion of the blue, giving a dark blue for the shadows, thus again giving a correct image of the blotter.

This subtractive method forms the basis of all modern color process printing and the commercially available photographic print color processes as follows: Sanger-Shepherd, Ives, three-color carbon, three-color ozobrome, raydex, pinatype, polychromide, etc.

Next come the single plate color processes, which have contributed largely toward making color photography commercially successful. In 1869 Louis Ducos du Hauron conceived the idea of combining the three taking filters of the three-color filter process into a single tri-color filter. He constructed the filter by ruling fine lines of the three primary colors, red, green and blue, on a transparent medium, coated on a glass plate, the lines being parallel, adjacent and arranged in the same consecutive alternating order of coloring all over the plate. An ordinary photographic plate would be exposed in the camera with its emulsion in contact with the tri-color filter plate, the latter being on the side nearest the lens, so that the light rays would have to pass first through the filter before reaching the emulsion on the photographic plate.

The theory of this process contemplates selective action by each filter line upon the line of light passing through it, with consequent selective action upon the emulsion behind each line. Thus the red parts of the image would only affect the emulsion behind the red lines on the filter; the green parts only that behind the green lines and the blue only that behind the blue lines on the filter.

After exposure the plate is developed and a positive made in the usual way. The positive and the tri-color filter would then be placed together again, care being taken to align the two so that the image lines on the positive corresponding to the red, green and blue filter lines on the negative were directly in contact with the corresponding red, green and blue lines on the tri-color filter.

On looking through the combined positive and filter, or on projection upon a screen, the picture would appear in its natural colors.

The fineness of the lines on the filter and therefore in the image on the positive, is so regulated as to make them individually indistinguishable, advantage being taken of the limitation of the eye in observing minute objects, as previously pointed out. This not only merges the lines together to present a solid image, but also brings about the resultant color combinations of the primary colors necessary to bring out all the various shades of color in the object.

Du Hauron's process was not capable of commercial development, due to the lack at this period of a satisfactory "panchromatic" plate, and also due to the mechanical difficulty of ruling up the filter plates.

During this same year, 1869, Du Hauron conceived the idea of coating the emulsion directly over the tri-color filter instead of using a separate plate, and after exposure and development, chemically reversing the negative to form a positive image. In order to overcome the mechanical difficulties involved in a ruled filter, he conceived the idea of dyeing minute particles of a transparent substance with the three primary colors, mixing them together intimately and spreading them in a single layer over the glass plate to form the tri-color filter, the emulsion then being coated upon it, as previously referred to.

It is obvious that this would give a heterogeneous pattern of color instead of a recurring regular pattern as in the ruled line filter. It is further obvious that only with a combined emulsion coating and filter as just described can such a filter be used, for it would be next to impossible to align such an irregular pattern with its corresponding positive as would be necessary where the panchromatic emulsion was on a separate plate. It follows, therefore, that a regular geometric arrangement of colors must be used in a tri-color filter, or screen (as we will now call it), where the separate single plate process is involved, and either a geometric or irregular arrangement may be used with the combined single plate process.

Lack of a satisfactory panchromatic emulsion and other difficulties prevented Du Hauron from achieving commercial success with the combined single plate process.

During the next forty years various experimenters worked to produce a commercially successful single plate process, notably Joly, McDonough, Powrie and Miss Warner. Their work was all very ingenious and very beautiful results were obtained, especially with the Warner-Powrie process, but commercially they never met with satisfactory development.

In 1904 the Lumieres of Lyons, France, patented the well-known "autochrome" process, which represents the successful development of a combined irregular single plate process, along the lines laid down by Du Hauron. This process leaves nothing to be desired so far as the production of transparencies, quickly, easily and with truthful color rendition is concerned. It is capable of producing very beautiful lantern slides upon the exercise of somewhat greater care and experience.

I will quote from a description of the process by Auguste and Louis Lumiere in a recent issue of *American Photography*:

"Grains of potato starch are separated by special machinery so as to reject all smaller than 10 or larger than 15 thousandths of a millimeter in diameter (0.0004 in. to 0.0006 in.). The grains once selected are divided into three lots, which are colored orange, green and violet by means of appropriate dyes. The colored grains are then mixed in such proportions as to give a mixture having no dominant color. The extremely intimate and homogeneous mixture of the three colored powders is then coated regularly, by means of special machinery, on plates of glass previously coated with a sticky varnish. After this operation, it is necessary to fill the spaces between the grains, which is done by another machine which coats the plates with an extremely fine carbon dust. This dust is retained between the grains by the sticky varnish. The plate, thus prepared, is rolled to flatten out the starch grains and produce a three-color mosaic. The plate, though covered with microscopic elements stained intense orange, green and violet, seems to present no coloration, because the orange, green and violet rays which traverse it combine to form white light.

"How can this mosaic of colored screens give birth to colored images? The mechanism of the genesis of colors is extremely simple. It is by subtraction, by the partial or total obscuration of such or such a colored grain, that the formation of the most diverse colors can take place. Let us suppose that we obscure the green and the violet grains; the orange grains alone remain, and the plate, viewed with the naked eye, presents an orange coloration. If we darken a single color, the hue of the plate is the resultant of light which comes through the other two. If the blocking out of a given grain, instead of being total, is partial, the resulting color can take the most varied tints.

"The sensitive emulsion is coated over the mosaic screen and automatically registers and reproduces the colors of the object. Exposure is made through the glass side of the plate so that the light traverses the colored grains and impresses the silver in proportion to the amount of the three primary colors present. On treating the plate with a developer, metallic silver is deposited over every grain through which light has passed in proportion to the amount of light action. Thus, if the object is green, every green grain will be covered with silver, and if the process were stopped at this stage the image would be red, because the image would be formed by the unaltered orange and violet grains. This image is the complement of that which it is desired to obtain.

"But if we dissolve, by means of appropriate chemicals, the silver reduced by the first development, the green grains would be freed and rendered visible, only we should still have the unaltered silver bromide covering the orange and violet grains.

"Let us proceed, then, in broad daylight to a second development. This unaltered bromide will be affected by light in its turn and blackened by the developer. Consequently the orange and violet grains will be masked in their turn and the green grains alone remain visible. We have thus reproduced the green image after having passed through a complementary red image.

"This explanation can be repeated for every other color, and one sees that all colors are formed by subtraction by eliminating, partly or totally, from the orange-green-violet layer, the elements of the colors complementary to the color which is to be obtained. This elimination, this selection, is effected automatically by the colored rays themselves coming from the object photographed.

"In practise the manipulation of 'Autochromes' is very simple. A special yellow-orange screen is placed on the lens. The plate, in contact with a sheet of black cardboard to prevent scratching of the sensitive coating, is loaded into the plate holder with the glass side towards the lens. The same developer (metoquinone with ammonia) is employed for both the first and second development. Reversal takes place in a bath of potassium permanganate acidified with sulphuric acid, and all processes after the flowing of this solution over the plate take place in broad daylight. Within 20 minutes of beginning work, a finished positive in colors may be produced, and as soon as it is dried it may be varnished and bound up like a lantern slide."

It should be noted that in this process as in all other single plate processes a compensating yellow or orange filter must be used on the lens to eliminate ultra-violet and cut down the violet and blue rays, as previously explained. It should also be noted that due to the action of the yellow filter and tri-color screen in cutting down the actinic value of the light, a great increase of exposure time over the ordinary plate is necessary, varying from 25 to 100 times that required for the latter.

Following quickly upon the autochrome came the Thames, omnicolore, and aurora, or Dufay dioptichrome single plate processes, each representing ingenious attempts to solve the problem in a slightly different way. All have achieved fair commercial success, but cannot be said to equal that of the autochrome from the standpoint of manipulation or results.

In 1913 the Paget single plate process was brought out, representing a development of the separate geometric screen method as laid down by Du Hauron. It involves a tri-color screen printed in checkerboard pattern upon the screen plate, the squares on the checkerboard being about 1-500 inch on a side. A separate taking and viewing screen, special panchromatic negative plate, special orange filter and special positive plate are necessary. Later the company succeeded in combining the viewing screen and the positive into a single plate. This process is capable of very beautiful results, is especially adapted for lantern slides and threatens to compete seriously in public favor with the autochrome process, having an advantage in its possibilities of duplication from the original negative, not possessed by the latter.

As to the future one may say it is very hopeful. The Lumieres and others are diligently working to perfect the bleach-out print process. The Eastman Company has recently induced the well-known English authority on this subject, Dr. C. E. Kenneth Mees, to join its staff at Rochester, and it is understood that he is actively directing the work along this line. It is the hope of all interested in this subject that the near future may have in store for us the perfected photographic print in natural colors.

German Plants in Belgium

It appears not to be generally known that many important manufacturing plants in Belgium belonged to Germans, and care was taken not to injure these in the bombardments. Zinc smelting is going on at Lommel and Overpelt, and concerns along the Meuse are in operation.

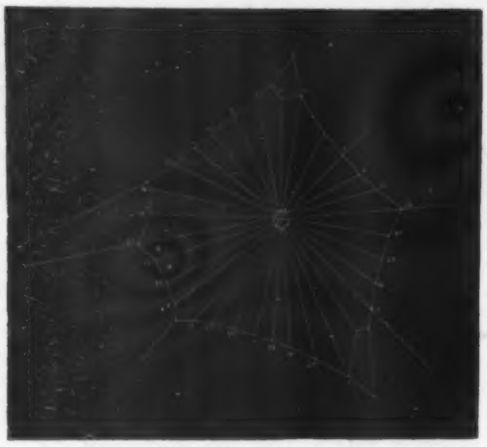


Fig. 1.—Diagram of the order of running lines.

Fig. 2.—9 P. M.

Fig 3.—9:50 P. M.

The Spinning of a Web*

A Wonderful Bit of Engineering and Technical Skill

By Frank Cuttriss

A HEAVY thunderstorm in the afternoon having completely destroyed and washed away every trace of the web which a half-grown female garden spider had made among the pines on the previous day—night, we should perhaps say, as we had arrived on the scene at midnight, just as she was completing it—we considered the circumstances favorable for carrying out a project we had long had in mind, that of watching the construction of a spider's geometrical web from start to finish.

By early evening the storm had passed, leaving the earth sodden, and the pine foliage sparkling with innumerable raindrops; thunder rumbled all around, while the clouds were still very heavy and threatening, and we were a little doubtful if the weather would permit us to keep our vigil.

At seven o'clock the spider lay close to the underside of the branch which it had chosen for its home. One could fancy it had foreseen the occurrence of storms, for no more perfect shelter could be imagined, the branch keeping off direct rain and the foliage around conducting all water away from the spider.

At half-past seven, at eight o'clock and half-past eight, when we visited it, no movement had occurred, and it appeared as though our trouble would be unrewarded.

We felt certain, however, that if it were likely to remain fine all night, with the prospect of a fine morning, the spider would appreciate it, and, by about midnight, construct a new web for the morrow.

Nine o'clock came, and although the clouds were as dense and stormy-looking as ever, we decided to visit our friend again and see what it was thinking. This time we were rewarded, for just as we reached the spot it left shelter, came out to the tips of the foliage, dropped down a line to a point a few inches below, ascended to about midway, turned head downward, and remained suspended for about fifteen minutes (see Fig. 2). It then ascended to its nest branch, and in a few minutes descended to a branch below.

* From *Knowledge*.

Five seconds later it ascended to its original position, taking up the line with it, so that at 9:25 P. M. practically nothing visible had been done.

Ten minutes later it again emerged, descended to a branch below, and made fast a line, which eventually formed two of the perpendicularly radiating lines. Ostensibly, therefore, the spider commenced the real business of making its web at 9:35 P. M. Next, from the tips of the foliage of its nest branch it let loose a long line with a free end, the object of which soon became apparent; for in a few seconds it became attached, at an angle of about forty degrees, to foliage on the lower left hand. Here the instinct—or reason—of the animal especially arrested our attention, as at the time the wind was blowing from the right directly in line with the position selected for the web, so that in a very few seconds the floating thread streamed out and was caught as described. Practically from no other point than that chosen by the spider for setting loose this line could the end in view have been attained.

We now conjectured a speedy completion of the structure, mentally allowing about an hour for the work. We reckoned, however, without our entertainer, for after having done a certain amount of groping about among the foliage in the vicinity the net result at 9:50 (see Fig. 3) was a rough framework, two upper and two lower lines radiating from a nebulous sort of ring, which was evidently determined upon as the center for the coming web. The architect now settled herself comfortably, head downward, at the junction, and took a long rest. Twenty minutes elapsed, and our spinner appeared suddenly to realize that time was going on, and set to work again, until at 10:27 P. M. most of the supports were fixed, and nine of the radiating lines were in position (see Fig. 4). The spider now ascended to the nest branch, and for a considerable time crept about among the foliage. At 11:10 P. M. it descended to the center, and remained there, head downward, for five minutes; at 11:15 it was again stirring, until at 11:37 the right-hand support or border line had been fixed as well as twenty-two of the radial threads. The twenty-seventh radius was fixed at 12:03 A. M., after which the spider returned to the center and remained head downward (see Fig. 5).

In every case where we say rested or remained in center of web, or elsewhere, we do not wish to convey the idea that the spider did absolutely nothing during the time, although for the most part no movement was noticeable.

At 12:30 A. M. (see Fig. 6) the last of the thirty-one radial threads was in position, the accompanying numbered diagram showing at a glance the order in which they were made (see Fig. 1). A short space of time between the placing of all the radii after the twenty-seventh was devoted to netting together at the center and fixing roughly concentric threads over larger or smaller segments, which the little creature accomplished by traveling to and fro, stopping momentarily to fix the thread as it went, the greater part of the central work being done after the fixing of the twenty-ninth radial.

A few seconds after this the spider commenced one of the most wonderful of the many astonishing features of geometric web-spinning, inasmuch as it apparently demonstrates foresight and the possession by the spider of reasoning powers which enable it to use the best means to accomplish the end in view. It affixed a thread near the right upper center, then by supporting itself on the radial threads and working towards the left it affixed its thread—always one remove back—in a beautiful volute of about two and three-quarter turns, which was completed at 12:40 A. M. (see Fig. 7).

The objects of this helical line, it afterwards became evident, were to keep the radiating threads properly taut and at the intended distances apart; also to some extent as a scaffold for the construction of the concentric portion of the web.

At 12:41 A. M. the outermost of the concentric threads was placed by the spider, working from the top towards the left, and upon arriving at the intended limit on the right it turned about and com-

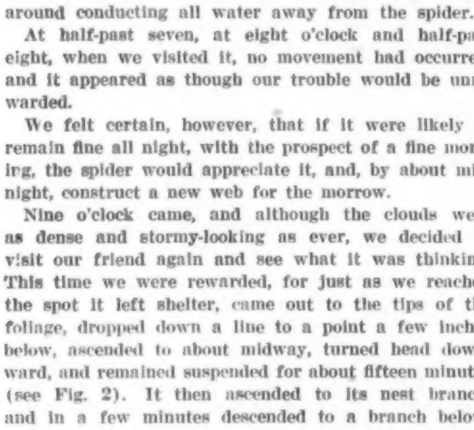


Fig. 4.—10:30 P. M.

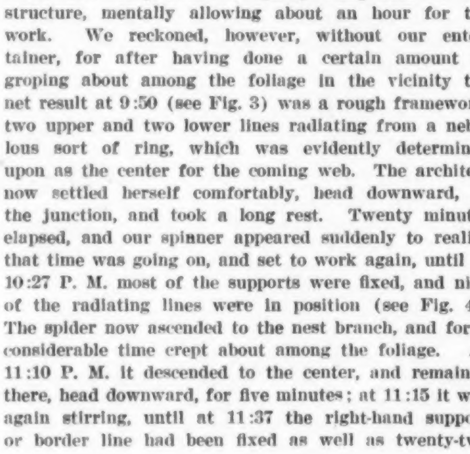


Fig. 5.—Midnight.

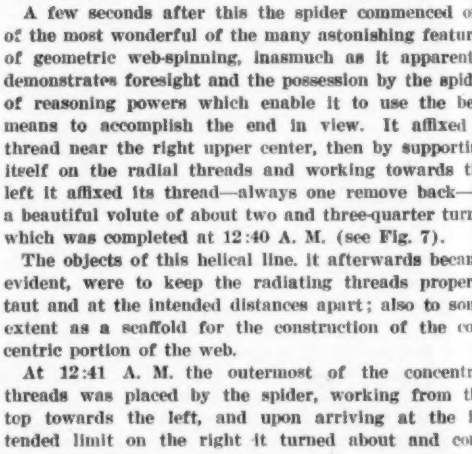


Fig. 6.—12:30 A. M.

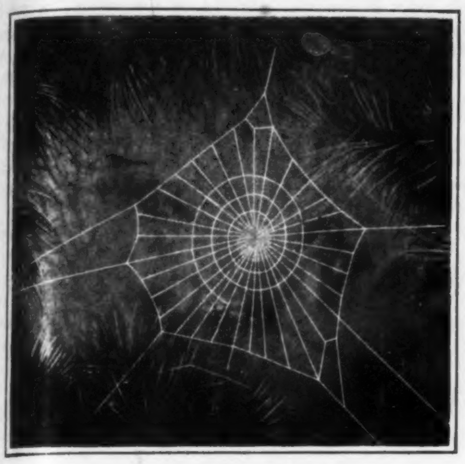


Fig. 7.—12:40 A. M.

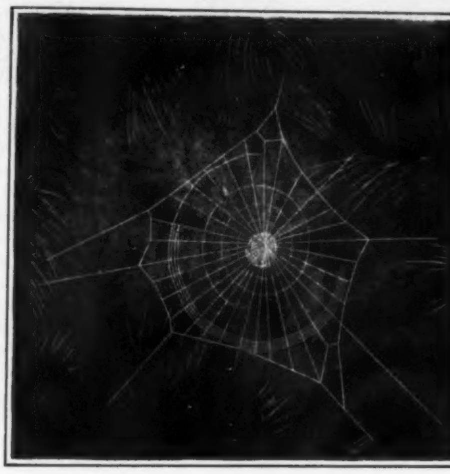


Fig. 8.—12:50 A. M.

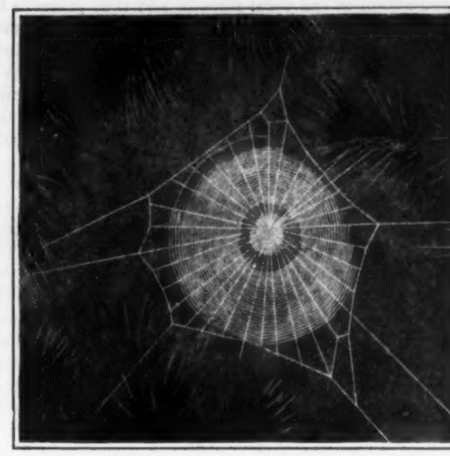


Fig. 9.—1:25 A. M.

menced the second thread, working toward the left by way of the bottom of the web.

At 12:43 A. M. four of these threads had been fixed, the spider accomplishing the work by climbing up two threads ahead, descending to just the right distance from the thread last fixed, bending its abdomen over the radius next to it, making a decided pause, and with the spinnerets getting the thread, which had exuded as it proceeded, fixed at exactly the right spot, holding the section just fixed with the hind foot on that side so that it should bear the strain during the operation; then up the next radius, and so on, over and over again (see Fig. 8).

Given a good illumination through the web, the most superficial observer would by this time have noticed that a very short time after each division of a concentric was fixed, it changed in appearance from the finest streak of reflected light to an apparently stouter and whiter line, and would recollect that none of the other lines—supports, radii, or central netting—underwent any such change. Upon closer examination and magnification this would be found to be caused by the running together into globules of a viscid matter, the result probably of the spider intentionally bringing into action a special secretion. We carefully noted the time elapsing between the fixing of a thread and the completion of the studding with viscid globules, and found it in every case to be exactly fifty seconds.

The spider now kept on steadily at work, the only variation in its movements occurring with the completely circular threads, all of which were fixed by the spider working in one direction only (from left to right) instead of turning about as at the end of an incomplete circle and working the next in the opposite direction.

Excepting when descending on a line, the spider appeared in every case to draw out the thread from its spinnerets by means of its hinder feet used alternately, while the temporary volute or helical thread was cut away, apparently by its fore feet, as the spider reached it in fixing the permanent concentric lines.

At 1:25 A. M. the finishing touch was given to one of the most perfect webs we have seen (see Fig. 9), and the little wonder-worker glided up a line connected with the intricate network in the center and took up its position to watch and wait on the underside of the branch, the shelter of which it had left nearly four and a half hours earlier.

The web constructed by this spider on the previous night—preceding the storm—had two stay lines attached, one on either side near the center, which were affixed to the foliage about four or five inches away.

The web we saw constructed had no stay lines, the succeeding day being calm and without rain. We noted these facts incidentally, but would consider it unwise in the absence of recurring confirmatory observations to attribute them to either premonition or coincidence.

In connection with the construction of geometrical webs it is interesting to note that, although the foregoing spider on three consecutive days made webs, each of which contained the same number (thirty-one) of radii, there appears to be nothing to determine the number of these radiating lines that any particular spider will make. Perhaps we ought rather to say that the factors determining such are at present beyond our knowledge.

An *Aranea umbratica* which we had under observation at the same time as our friend *diademata* constructed—also at midnight—a web twelve inches in diameter. This, while much larger than that of the garden spider, was much more open in structure—a characteristic of this species—and contained twenty-two radii only, which at the outside of the web were necessarily so much further apart than those of *diademata* as to render it difficult to construct the outermost concentric threads. To obviate this difficulty the spider made a temporary helical line of six coils instead of the three, which, exending much nearer to the outer edge, enabled the spider to use it comfortably as a scaffold to get on to the next radius, along which it slipped foot after foot, precisely in the manner of a tit descending a cord, until in position for affixing its thread.

Again, the web of a *Zilla notata*, six inches only in diameter, had forty radiating threads, while a younger spider of the same species constructed a web, containing but twenty radiating threads, across the mouth of a jug.

A vast field for research in this direction is open, and, although there is evidence of increasing interest in the ways of the much-maligned spider, it would seem that the fringe only of the subject has been touched, and it may well be said of it, as of everything else in nature, that he who knows most concerning it knows best how little he knows.

"Standardizing" the Art of Voice Production

The Fundamental Underlying Principle of Developing the Vocal Muscles

By Floyd S. Muckey, M.D.

The writer considers the establishment of a real standardization of voice production to be the most vital need of the voice-teaching profession. The present attempts at standardization, however, are not only futile but harmful, because they give the musical profession and the student public an entirely false idea of the nature and scope of this problem.

All effective singing and speaking involves two things —correct voice production and interpretation. Without correct voice production our speech and song degenerate into mere mummery and disagreeable sounds. This effect often becomes distressing or ludicrous to the listener on account of evident bodily strain or facial contortion. With correct voice production the matter of interpretation becomes comparatively simple. The latter depends upon the knowledge and experience of the singer, or in other words upon his mental capacity. Since this mental capacity cannot be supplied by the voice teacher, his task can only be to teach the pupil how to secure the correct action of the vocal mechanism. This correct action consists in the free swing of the vocal cords, the free motion of the cartilages of the larynx, and full use of the resonance space. We know that this correct action will occur if the voice mechanism is not interfered with, and we also know that incorrect action is due to this interference. There are various forms of interference, each of which leaves its impress upon the quality of the tone. The ear of the teacher may therefore be trained to hear in the quality of the tone the interference with the mechanism. This ability to diagnose interference is the first essential qualification of the voice teacher. Correct voice production is involutary and must necessarily be so, while interference is voluntary. Any attempt then *to do anything* directly with the mechanism or with the voice itself will inculcate interference and render voice development (development of the vocal muscles) and correct voice production an impossibility. A knowledge of the nature of the voice and its mechanism and of the nature of interference must point out the method of its removal. The universal tendency of the voice teachers of to-day is to attempt *to do something* with the voice and its mechanism, and hence to develop interference instead of removing it. For example, all attempts to "place" the voice, to get the tone "forward," to "focus" the tone, or to give it any particular "direction," mean the use of voluntary muscles in voice production. This use means interference, which hampers the free action of the vocal muscles, thus weakening instead of strengthening them. The result of this wrong teaching is that the voices of to-day (both speaking and singing) are mere caricatures of what they should be. Furthermore, these voices are at their best for only a few years at most, while if they were properly produced they should last until the vocal muscles become palsied by old age. More than this, the hampering of the voice mechanism by interference takes the mind of the singer away from the sentiment expressed by the words. Nature never intended the singer or speaker to give any thought to the production of his voice. For this reason the voice mechanism was made involuntary, so that the whole mind could be centered upon interpretation. Psychology has nothing to do with voice production, but is a most important consideration in interpretation.

The word *standard* means a measure. The thing to be measured in the present instance is the teacher's knowledge. This knowledge must be such as will enable him to diagnose and eliminate interference with the voice mechanism and to show the pupil how to develop his vocal muscles. What then must the vocal teacher know to enable him to do this? He must know that the voice is a complex sound, that each voice tone is composed of several simple tones varying in pitch and intensity. These simple tones are called the fundamental tone (the lowest pitch) and the overtones. He must know that the elements of voice tones are first pitch, second volume, third quality. Pitch depends upon the rate of vibration of the fundamental tone, volume upon the sum of the intensities of the partial tones, and quality upon the number and relative intensities of these tones. He must know that a wide range of pitch is absolutely dependent upon a free motion of the cartilages of the larynx, and that the best volume and quality of tone cannot be secured without an unhampered swing of the vocal cords and full use of resonance. It is this correct action of the mechanism which produces a strong fundamental tone—the essential in good volume and quality. He must be able to recognize instantly the quality produced by a strong fundamental. He must know that the conditions in the throat which produce the strong fundamental tone are such as give an unham-

pered action of the vocal muscles and thus preserve the mechanism. He must know that resonance is the most important factor in both volume and quality of tone, and that this is caused by the sympathetic vibration of the air in the cavities of the pharynx, mouth and nose. He must also know that the most rapid development of the voice (vocal muscles) is secured by the daily practices of short soft tones without interference.

While there are many other things which the voice teacher should know, these are the fundamental factors underlying correct voice production and must form the basis for a standardization of this subject. From the foregoing premises the conclusion is inevitable that the diagnosis and removal of interference, and a knowledge of how to develop the vocal muscles, are the essential qualifications of the singing teacher. In the light of these statements let us analyze the "recommendations" which were adopted by the New York State Music Teachers' Association last June. This association is one of the oldest and supposedly the one most capable of putting forth a correct standard for the regulation of voice teaching. The chairman of the Standardization Committee announced that the following set of "recommendations" for the standardization of voice teaching was the result of the work of various committees appointed by the association during the past twenty-six years:

"The Vocal Conference of the N. Y. S. M. T. A., twenty-sixth Annual Convention, held on June 18th, 1914, unanimously adopted the following recommendations presented by the chairman, looking toward the establishment of a standard of musicianship for teachers of singing who desire to become active members of the association:

"Resolved, that before a person is considered qualified to teach singing he should demonstrate to the Examining Committee, first, that he possesses an ear accurate in the appreciation of differences in the pitch and quality of musical tones and in the pronunciation and enunciation of the English language; second, that he has sufficient pianistic ability to play simple accompaniments; third, that he has had at least three years' continuous study with some competent teacher; fourth, that he possesses such elementary knowledge relating to general musicianship as is contained in such a book as 'Musical Essentials,' by Maryott; fifth, that he is familiar with the contents of one or more standard works dealing with Tone Production, Voice Development and Interpretation; sixth, that he possesses the ability to impart his knowledge, i. e., to teach; seventh, that he has some familiarity with teaching material, in the shape of vocal exercises and songs."

To show that even the first "recommendation" in this list is not an essential, although it is by far the most pertinent, the writer would merely state that Prof. Halleck of Columbia University, with whom he collaborated in working out the Natural Method of Voice Production, was absolutely deficient in what is known as a "musical ear." He could not tell "Yankee Doodle" from "Old Hundred," and yet during the course of this investigation his ear became trained to hear interference just as readily as the writer's. With some experience in the removal of interference he would have become a first-class voice teacher. This shows that while "musical ear" is a decided advantage to the singing teacher, it is not an absolute essential. On the other hand, there are thousands of persons who possess this "musical ear" but who are absolute failures as voice teachers, for they know nothing about the diagnosis and elimination of interference and the development of the vocal muscles.

In considering the second qualification outlined in this standard what is the connection between playing an accompaniment and the diagnosis and elimination of interference? Does the accompaniment played by the teacher take away the interference with the voice mechanism of the pupil? The proposition only needs to be stated to show its absurdity. The ability to play an accompaniment is not an essential qualification of the singing teacher.

Number three states that the applicant must have had three years' continuous study with some competent teacher. It becomes necessary at once to define the competent vocal teacher. According to our definition the competent vocal teacher is the one who can diagnose and eliminate interference and show the pupil how to attain full development of the vocal muscles and thus make use of all the capabilities of the vocal structures. The competent vocal teacher should be able to eliminate all interference at once within a limited range and daily practice for from two to three years without interference should give full development of the vocal muscles with the result that there would be a perfect use of the voice mechanism or perfect tone production.

It must be understood that in the beginning a tone produced without interference will be very small, but will grow stronger as the vocal muscles develop.

There are no singers singing without interference. All of them have soft palate interference, and on the loud and high tones tongue and false cord interference as well. Soft palate interference (raising of the soft palate) takes away more than one-half the resonance space. False cord interference prevents the free vibration of the true vocal cords, while the tongue muscles interfere with the correct action of the pitch mechanism.

This combined interference causes a loss of more than one-half the capabilities of the voice mechanism. It greatly reduces the volume, limits the range, and destroys the natural quality of the singer's voice.

The result is that the voices of our public singers are greatly deficient in these three elements of voice production. Such a condition of affairs could not result from competent voice instruction. Such instruction, covering a period of five years, should show some pupils singing their loudest tones without interference. Under these conditions how is the applicant to comply with the third "recommendation"?

The fourth "recommendation" deals with the elementary knowledge of general musicianship. While this knowledge is of advantage to a voice teacher or to any one else for that matter, even a profound knowledge of this subject would not aid the voice teacher in the diagnosis and elimination of interference and the development of the voice (vocal muscles). This knowledge of general musicianship is not an essential to voice teaching.

Familiarity with standard works in Tone Production, etc., constitutes the fifth "recommendation." The writer is acquainted with practically all the works written upon the voice and he is in a position to state positively that there has not yet been written a work on tone (voice) production or voice development. The various definitions given to the voice prove the truth of this statement. The voice is defined by different writers as "vibrated breath," "vitalized breath," "product of the mind," "gift from God," etc.

A logical discussion based on these definitions would result in a treatise on Meteorology (vibrated breath or air currents), Biology (vitalized breath), Psychology (product of the mind) and Theology (gift from God). This is precisely what we find in these so-called books on voice production. Instead of discussing the voice from its true definition of sound (air-waves) these authors endeavor to describe voice phenomena by a discussion of other sciences. The result is a hodge-podge of the various sciences mentioned. The terms used are necessarily figurative and can give the student no definite idea of the voice or its production. These works can, therefore, afford no assistance in the diagnosis and elimination of interference and the development of the vocal muscles.

A knowledge of the anatomy, physiology and physics of voice production is essential to any intelligent discussion or teaching of the voice. Since there are no standard works on the voice, the student is unable to conform to this "recommendation." The sixth "recommendation" states that the applicant must have the ability to impart his knowledge. The ability to impart knowledge presupposes the possession of such knowledge. Since there are no competent vocal teachers and no standard works on the voice, how is the applicant to acquire a knowledge which will enable him to diagnose and eliminate interference and instruct his pupils how to develop the vocal muscles?

In regard to the seventh "recommendation," the teacher might be familiar with all the exercises ever used in voice development, and all the songs ever written, and still know absolutely nothing about the diagnosis and removal of interference and the development of the vocal muscles. An exercise is only of value when it is performed without interference, and a song is simply a form of exercise.

This seventh "recommendation" requires no knowledge essential to voice development.

If anything is ever to be accomplished in voice production there must be a real standardization for the following reasons: Every voice is sound, and in every case voice production is sound production. The laws which regulate this voice production are precisely the same in every singer and speaker, and every mechanism which produces the voice is exactly similar. Every vocal mechanism is composed of the same elements—vocal cords, muscles and cartilages of the larynx, and resonance cavities. The vocal cords are of the same material—yellow elastic tissue—the action of the muscles and cartilages is precisely the same in every individual, and the conditions which give full use of the resonance space are identical in every speaker and singer. Differences in the size and shape of these various elements account for individual characteristics of voice. For these reasons there can be but one standard method of voice production. An applicant might comply with all of the "recommendations" of the New York State Music Teachers' Association and still know nothing at all about the Standard Method of Voice Production.

On the other hand, an applicant might possess an accurate knowledge of this standard method and still be unable to comply with a single one of the "recommendations."

The several state attempts at Standardization are similar in character to that of New York. The efforts at Standardization thus far are, therefore, futile.

The only basis for a real standardization is a knowledge of the anatomy, physiology and physics of voice production and its proper application to the voice mechanism. This has been carefully worked out by the voice investigation at Columbia University recently completed. Any association interested in Standardization need only standardize or measure the knowledge of its applicants by this standard knowledge.

An Insoluble Seal for Letters

By "Delta"

A SEAL that will prevent surreptitious opening of letters has long been desired. Most envelopes can be only too easily opened by simply steaming one end; the letter is then withdrawn, read, returned and resealed at one operation. But a paper seal can be readily made which will render any letter proof against being opened by steaming, the ends as well as the central flap being secured at the time of closing the envelope.

The seal is made as follows: Use a moderately glazed paper as a base for the seal. Prepare a solution of gelatine, consisting of 40 grains of gelatine to the ounce of water. This should be allowed to soak for half an hour, and then may be melted by placing the vessel into boiling water. When the gelatine has melted, stir the mixture well and then with a flat brush apply the gelatine solution lengthwise on the paper which should have been previously dampened. Then hang up the paper to dry. When dry, coat the paper again, brushing the sheet crosswise, then dry it once more, pinning the sheet at each corner to prevent it from curling. When dry, lay the sheet face down, and brush the back all over with amyl acetate collodion in a concentrated state, then hang it up to dry again. Suitable strips may now be cut from the sheet to form the envelope seals. To use these upon the envelope, all that is necessary is to dip each one into a solution of common alum for about half a minute, made up of 120 grains of alum in four ounces of filtered water, or 90 grains of chrome alum. Then place the seal over the flap of the envelope after it has been fastened down in the usual way, and, placing a piece of blotting paper upon it, rub it down with the thumb nail until the seal lies flat. It will be found that when the seal has become dry, the gelatine has become insoluble. It will not be softened by a lengthened period of steaming. The coating of amyl acetate collodion makes the seal quite water proof, so that prolonged steaming or even scalding with hot water will not cause the seal to loosen, and any attempt to remove the seal will leave a tell-tale mark. The paper composing the envelope may soften and the mucilage beyond the gelatine seal liquify, but the seal itself will not give way.

Concentration and Co-operation in Science*

IN astronomy, for example, the great strides that have been made in the present generation can be attributed to two things; first, there is the unprecedented concentration of effort. Great telescopes have been erected and great observatories have been built for the purpose of solving single problems or a single group of closely related problems. If these problems should remain unsolved in our time the work will be carried forward by a succeeding generation and perhaps completed many years after those who initiated it have passed away. Co-operation is another powerful implement that time has placed in the hands of the astronomer, more precious to him than any telescope or any observatory can be. Thanks to it, no pressing problem appears at present above our horizon that is too great for him to attack. If you will examine the working programmes of our astronomical institutions, you will find that much the greater half of what they are doing is being carried out with direct reference to the needs and the activities of other institutions. Co-operation often makes severe demands upon the individual; it means that he must be willing to use his mental and his material equipment in furthering an impersonal plan; it means that he must sometimes subordinate his own judgment to that of others; it means that he must sometimes use methods that he would like to modify in some particular if he were working alone.

*From an address by Prof. Frank Schlesinger, at the meeting of the American Association for the Advancement of Science.

The Chemistry of the Incandescent Gas Mantle*

The Materials Employed and the Steps Taken in its Improvement

By Dr. H. S. Miner

IN responding to the invitation to tell you some of the new developments in the chemistry of the incandescent gas mantle, I very much fear that my hearers will be doomed to disappointment if I am expected to describe some startling change that has taken place in that industry. Since the wonderful and spectacular invention of the brilliant Austrian chemist, Dr. Karl Auer von Welsbach, who about 30 years ago produced the incandescent gas mantle which in all justice bears his name, the growth of the industry has been marked by steady improvement rather than revolutionary changes, unless indeed we are to include that radical change in the composition of the mantle body which Dr. Auer himself made, when in the early nineties he substituted the thorium-cerium mixture for the more complex lanthanum-zirconium-cerium mantle which had comprised his first commercial mantle body. This was indeed a radical improvement, and it marked the beginning of the general adoption of the incandescent gas mantle.

I have said that the days of *radical* developments seem to be in the past, and yet I never cease to wonder at the phenomenon of the change or petrifaction of the vegetable or organic fiber, reproducing the cellulose fiber in mineral form under the influence of the Bunsen flame and giving the light-producing body with which we are familiar. And although we hear the fragility of the mantle frequently alluded to, yet when I watch its formation in this manner, which seems to be essential to its light-giving efficiency, the strength and resiliency of the mantle is a "nine days' wonder" to me.

The change in the composition of the Welsbach mantle when the mixture of 99 parts of thoria and 1 part of ceria was substituted for the earlier mixture, has ever been to my mind an invention of the highest type, involving as it did the purification of rare earth materials beyond the limits of previous knowledge, and then the development of commercial processes for the production of these rare earths in the highest state of purity.

Notwithstanding the extravagant claims made by many *pseudo* inventors, the thorium-cerium mixture still holds as the essential composition of all Welsbach mantles, and this, and this alone, is the basis of the light-giving qualities of the incandescent gas mantle; although the last quarter of a century has brought us much enlightenment upon the field of rare-earth chemistry, no satisfactory substitute has been found for this early invention of Dr. Auer's. An intimate knowledge of this industry from the very days of its infancy leaves me with an ever-increasing respect for the work of the pioneer, Dr. Auer.

In justice to the faithful and meritorious work of the many rare-earth chemists throughout the world, I would say that their work has resulted in certain changes and improvements in the mantle and burner which have decreased its cost and increased its efficiency and durability. Some of these points I will touch upon.

In the early days a purified cotton fabric was saturated with the thorium-cerium mixture made of materials of as high a state of purity as possible. The purity of the cellulose was found to be absolutely essential, and the well-known bleaching and washing processes were carried beyond the point previously thought to be necessary, and a cotton carrying less mineral substance than the best absorbent cotton was soon produced. Realizing the deleterious influence of foreign substances, such as silica, lime, magnesia, alumina, phosphoric acid, etc., it was recognized that it was just as harmful to have these elements brought to the mantle from the vegetable fiber as from the rare-earth mixture.

It was early recognized that the length of the fiber or staple of the mantle fabric had much to do with its physical strength and its durability. Long staple cottons were used exclusively in the best grade of goods, and the longer fibered ramie or China grass was looked upon with favor when it was first introduced, but it was not used with any success by mantle manufacturers until it had been successfully de-gummed, bleached and washed. The accomplishment of this complex and difficult problem resulted in the adoption of ramie as a mantle fiber, first in Germany and then in other countries. The adoption of ramie fiber made possible the mantle of the inverted or pendant type, which has since been so generally adopted.

Although the staple of the fiber had been increased in length from 1½ or 1¾ inches to 5 or 6 inches by the substitution of ramie for Sea Island cotton, and that with certain advantages, especially in inverted mantles, yet the ideal had not been reached, and it remained for the artificial silk or artificial cellulose fibers to supply that ideal. The delay in the development of the artificial silk industry caused a delay in the adoption of artificial fibers as a mantle-making body, but its many striking qualities of strength, elasticity and maintained candle-power, have caused a persistence of effort that now had its reward in the arti-fiber mantle.

In the early days, the only digressions from the ideal composition of 99 per cent ThO_2 to 1 per cent CeO_2 were slight variations in these figures within narrow ranges to produce lights with varying degrees of whiteness, an increase or decrease of ceria increasing or decreasing the yellow color of the light produced. The coming of ramie fiber and the inverted type of mantle made the introduction of small percentages of hardening materials essential, and beryllium oxide was found to be an ideal substance for this purpose.

The change of fiber and of the type of the mantles as indicated has caused a complete revolution in the processes of manufacture, and notwithstanding the experience already gained, each one of these changes has called forth a line of research that had made persistent work over a period of years essential before the problem could be considered solved. This is especially true of the arti-fiber mantles, and the changes in manufacturing processes have extended to the collodion or lacquer used to strengthen the mantle for transportation, for the collodion used on the cotton or ramie mantles was found to be entirely unsuited for arti-fiber mantles.

The problem of primary importance for the chemical engineer, as related to this industry, has ever been the manufacture of thorium nitrate, and many changes in the commercial production of this substance have, of course, been effected during the score of years just past. Monazite sand has always been, and still is, the only commercial ore from which thoria could be obtained, and contains from 5 to 6 per cent ThO_2; although small deposits of thorite and thorianite with a thoria content of 50 per cent and 75 per cent respectively have served to keep alive within us an appreciation of, and longing for, a more ideal ore as a source of supply. The high price of monazite—this very low-grade ore from a thoria standpoint, with nearly 95 per cent waste—has thrown upon the thoria content, while still locked up in this phosphate rock, a heavy burden of expense and has made necessary the production of high yields and low costs of operation to keep the cost of thorium salts low enough to make them commercially available.

The first processes used in factory practice were naturally but enlargements of the well-known laboratory methods of analysis, while from this beginning have developed modification after modification, substituting cheaper and cheaper reagents and methods of manipulation until the commercial processes of to-day hardly bear even a "family resemblance" to the first process employed. These modifications are, of course, still continuing, and are made imperative by the fluctuation in price, either of the ore, of some reagent, or of the price of labor. But although there be variations in processes, there must be one unvarying standard ever before the chemist in charge and all of his associates, and that is the absolute purity of the product. Pure thoria is vitally essential, and I am gratified to be able to say for the thoria manufacturers of the world that their product is of very high grade, and is better now, notwithstanding the cheapening and shortening of processes, than it was in the beginning, although even then it was sincerely labeled "C. P."

There are various means, both chemical and physical, of checking and determining the purity of the product, but in the light of experience the most satisfactory method for both accuracy and rapidity is the manufacture of mantles from the thoria as it progresses in purity. The color of the mantle body, the color of the light produced, the presence or absence of shrinkage, the brittleness or flexibility of the mantle, give to the experienced manufacturer a more satisfactory indication of the purity of the product than do the chemical analyses, which are of necessity long and tedious.

The other essential material which must always accompany thoria is ceria, and although it is used in only about one one-hundredth the quantity as thoria, yet its chemistry is just as important and its purity just as essential. I am glad to say that this product is even purer than when Dr. Auer first used it even in larger proportions in his lathanum-zirconium-cerium mantle. The oxide of cerium then obtained was of a reddish-brown tint, while that now manufactured is of a light yellow color, the former product having been slightly contaminated with neodymium, the last traces of which were difficult to remove.

By way of variety, and in order to add zest to the work of the mantle chemist, he has also to manufacture beryllium, zirconium and neodymium, each of which he uses in a limited way, and none of these substances are really easy to produce.

Radio-chemistry has recently thrown the thoria manufacturer into the "lime-light" because of a radio-active product three hundred times stronger than radium, which occurs in and is produced from the thorium which he manufactures. I refer especially to mesothorium, which a suffering and stricken humanity has implored the thoria manufacturers of the world to save for them, and which these manufacturers are now unitedly conserving as a substitute at least for radium.

With the possible exception of the meso-thorium just referred to, every problem we have mentioned has a bearing upon the characteristics and qualities of some or all types of incandescent gas mantles. There is another and no less important problem, however, that should be alluded to, and that is the protective coating that must be applied to a finished mantle to strengthen it temporarily for transportation. In the early part of 1888 we were dipping the finished mantle in an alcoholic solution of shellac, made slightly flexible upon drying by the addition of a little castor oil. Some essayed to strengthen the mantle by the use of paraffine, and I have in my collection of curios a mantle imbedded in a cake of paraffine, which was to be removed by the melting away of the paraffine wax.

The invention of solutions of nitro-cellulose or soluble cotton opened up a new field of research, and the knowledge gained of the many various forms of nitro-cellulose and the numerous solvents therefor, together with the knowledge and control of such characteristics as viscosity, hydroscopic effects, etc., have made it now possible to prepare collodion solutions of almost ideal qualities for mantle purposes.

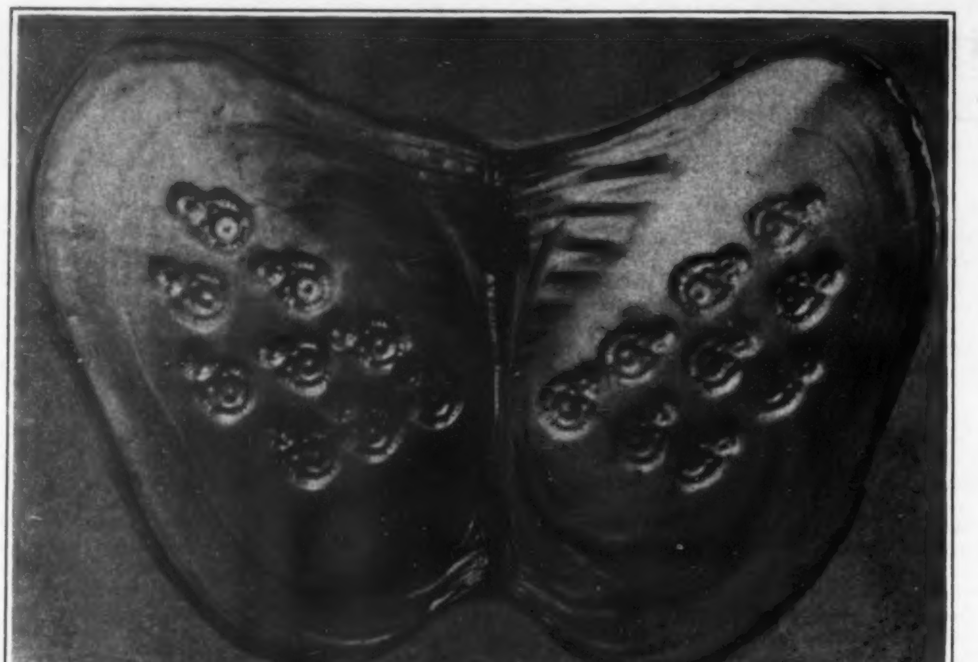
And what are these ideals? A collodion must be of the proper viscosity for mantles to be dipped in and withdrawn from it without rupture or strain; it must dry quickly with a film stiff enough for the mantle to be handled with safety, and yet strong and elastic enough to resist handling and shock; it must burn off slowly enough to prevent the mantle from becoming annealed or softened, and yet it must not leave the mantle body sticking to the cap of the burner. A collodion which answers these ideal characteristics is now realized in a nitro-cellulose solution in a mixture of solvents with camphor made flexible chiefly by the use of castor oil.

I said in the beginning that the type of spectacular developments in the incandescent mantle industry were apparently over. At the close of this very general review I am, however, strongly tempted to modify this statement, and to class the commercial development of the arti-fiber or artificial silk mantle in this class of achievements.

The mantle manufacturer has held before himself for a quarter of a century and more certain ideals toward which he has earnestly striven. Some of these have been strength with elasticity, high and maintained candle-power, preservation of color and absence of shrinkage. A realization of these ideals seems finally to have been met in the mantle made from the bundle of elastic, spring-like fibers known as artificial silk, for the strength of these mantles certainly is something phenomenal, the high initial candle-power is not only maintained, but is frequently *increased*. This is made possible by the practical absence of shrinkage upon prolonged burning and by the very curious phenomenon that this mantle does not seem to collect the fine mineral dust from the atmosphere as do those manufactured from the shorter vegetable fibers, cotton and ramie, this silicious dust having a very great affinity for the basic materials of the mantle body.

The attainment of this ideal has been reached only after years of persistent research guided by many more years of experience in mantle manufacture. Old theories had to be abandoned and former methods completely changed before this mantle was commercially possible. This was a chemical problem of great complexity, and its successful solution arouses such enthusiasm within me that I am tempted to include this among the radical and spectacular developments in our industry.

* A paper read before the New York Section of the American Electro-chemical Society, in combination with the American Illuminating Engineering Society and the American Gas Institute.



A clam shell from China with images of Buddha covered with mother-of-pearl.

The Artificial Production of Pearls

By F. E. Chidester, A.M., Ph.D.

THE shell of the mussel consists of three layers. The outside horny layer is called the *periostracum;* the middle *prismatic* layer is formed from tiny prisms of calcium carbonate separated by thin layers of the horny conchiolin found in the periostracum; the inner layer is the *nacre* or "mother-of-pearl," which consists of alternate layers of calcium carbonate and conchiolin arranged parallel to the surface. The periostracum and the prismatic layers are secreted from the edge of the mantle, while the nacre is secreted from the whole of the epidermal surface of the mantle. (Parker and Haswell.)

Many centuries ago the Chinese discovered that if foreign substances were placed between the mantle and the shell of a mussel, in many cases a coating of "mother-of-pearl" was laid down. The photograph shown herewith is of a clam now in the Conchological collection of Rutgers College. The wire images of Buddha were placed in the shell, and after a time (probably at least a year) the shell was removed from the water with the images uniformly coated with nacre.

The Japanese have developed the earlier work of the Chinese to a great enterprise under the guidance of the late Prof. Mitsukuri, opening the oysters slightly and inserting bits of sand, images, and particles of limestone, with the result that in many cases pearly excrescences, blisters or "culture pearls" are produced. These blisters are not of any great commercial value and, until recently, attempts to produce free pearls have been notably unsuccessful. A Japanese scientist, Mr. Mikimoto, has produced a few small free pearls by artificial means, but with such difficulty that the enterprise is not commercially profitable. It remained for Dr. F. Alverdes, working in the laboratory of Prof. Korschelt at Marburg, to produce free pearls by mechanical treatment.

Several causes have been suggested for the origin of pearls. Herdman thought that Cestode larvæ were the sole cause of the formation of pearls in the Ceylon pearl-oyster. (Jameson '12a.) Jameson ('02) showed that in the edible mussel, *Mytilus edulis*, pearls are formed as a result of the stimulation of a trematode worm, Gymnophallus. In this case the worm is surrounded by a sac composed of the shell-secreting epidermis, and the sac lays down concentric layers of shell substance and forms a pearl. Jameson opposes the theory of Herdman that the pearls found in the Ceylon oyster are caused by a tapeworm and considers foreign nuclei as exceptional. ('12a.) Rubbell ('11) opposes the parasitic origin of pearls in the fresh-water mussel, finding that they originate around particles of the chitinous periostracum.

Dr. Alverdes distinguished between nucleated and non-nucleated pearls. He calls a nucleus a central body not composed of one of the shell-substances. Frequently the center of a pear is a periostracum center. The nucleus of a pearl may be a parasite, an ovum or a fragment of tissue, or even a bit of quartz. ('13.) Alverdes injected into the connective tissue mantle parenchyma fragments of the shell-secreting epidermis of the mantle, and in other cases a disk of tissue containing both the epidermis and the ciliated lining of the mantle cavity. In both cases the epidermis lived if it found its way into one of the cavities of the parenchyma. (Jameson '14.) It surrounded the cavity with epidermis and formed a closed pearl-sac. Jameson concludes ('14) from the work of Alverdes and others that the real determining factors of pearl production are to be sought in the presence of an island of epidermal tissue in the sub-epidermal tissues, this island having been formed by mechanical processes as in Alverdes's experiments; by a specific parasite, as shown by Jameson in Mytilus; or as Rubbell has shown in the fresh water mussel, from a derangement of the normal mechanism of shell secretion. Alverdes's experiments proved that a nucleus is not necessary for the formation of a pearl.

BIBLIOGRAPHY.

Alverdes, F.

'13. *Zeitschr. wiss. Zool.*, Bd. 105, ss. 598-633 (2 plates).

'13a. Versuche über die kunstliche Erzeugung von Montelperlen bei Süsswassermuscheln.

Zool. Anz., Bd. 42, ss. 441-458.

Jameson, H. L.

'02. *Proc. Zool. Soc.*, vol. 1, pp. 140-166.

'12. Biological Science and the Pearling Industry.

Trans. Sec. D. Report of Brit. Assoc. Adv. Sc. 1912, pp. 487-488.

'12a. *Proc. Zool. Soc.*, 1912, pp. 260-358 (15 plates and 9 figures).

'14. Artificially Induced Pearl Production.

Knowledge, vol. 37, pp. 41-45 (3 figures).

Rubbell, A.

'11. *Zool. Jahrb.*, Bd. 32, ss. 287-366 (2 plates and 6 figures).

Industrial Uses of Hydrofluoric Acid*

THE larger works on Chemical Technology[1] give the following uses for hydrofluoric acid:[2]

1—Liquid or gaseous hydrogen fluoride is used for etching glass. The liquid leaves a smooth transparent surface, while the gas leaves a rough opaque surface.

2—Hydrofluoric acid in connection with fluorides of the alkalies and some other additions, such as acetic acid or sulphuric acid and others, are used for frosting glass. For this purpose there is in general use a solution of acid ammonium fluoride in hydrofluoric acid. This has the trade name of "White Acid" and contains about 32 per cent NH_4FHF and 20 per cent HF. It works very quickly, e. g., the frosting of electric bulbs requires only about a minute.

3—In the manufacture of spirits from cereals to retard the development of certain bacteria. The yeast is gradually rendered immune to the effects of the acid or its salts, so that the yeast itself is not harmed, but the bacteria which causes the formation of lactic or butyric acid are killed; thus a purer product and a larger yield are obtained. Very small amounts of hydrogen fluoride are sufficient. Effront, who worked out this process, recommends from 5 to 10 grammes hydrogen fluoride per 100 liters of mash. It is not used in the manufacture of whisky, as it is feared that it may have an influence on the flavor. This seems to be well founded, as the flavor of whisky is at least partly due to ethers of the fatty acids.

Ammonium fluoride is, however, used in the fermentation industry to sterilize vessels and rubber hose. But these are always carefully washed with water before they are used again.

4—For the preparation of hydrofluosilicic acid and its salts. (Moissan.)

5—To remove alkalies from the juice of sugar beets. (Thorpe.) This is probably only a proposal and it is not likely that it has ever been carried out on a large scale.

6—To remove silica and silicates from ground anthracite to be used for the manufacture of artificial coal for electrical purposes. This process was carried out for some time on a large scale by F. v. Hardtmuth,[3] but was finally abandoned again as too expensive.

7—To purify crude graphite.

8—For treating earthenware vessels to render them more porous.

The last two uses are mentioned by Prof. Prior[4] in 1903, but I could not find any details in the literature.

9—In dyeing, the antimony acid fluoride[5] is used as a substitute for tartar emetic.

10—To remove substances which have been added to silk to make it appear heavier. (Dammer.)

This process is probably used only in the laboratory in the examination of silk fabrics.

11—In the laboratory, to dissolve and to remove either free or combined silicic acid.

12—To clean sand from cast iron and to remove obstructions from natural gas or oil wells.

I have not learned how much the last named use of hydrofluoric acid is practised.

These last two uses are apparently not practised in Europe. They are mentioned in some of the works on chemical technology, but these all refer to an article published by myself[6] in 1896.

To those uses which have been made known through different publications, the following four, which as far as I know have not been published but are in use in the United States, can be added:

Besides for cleaning cast iron, the acid is also used in large quantities either alone or mixed with sulphuric acid to clean steel pipes to be used to inclose electrical conduit wires. It is also very useful for cleaning brass and similar castings.

The particular advantages over other methods for the same purpose are: 1—This acid dissolves the sand direct, while other acids only loosen it and cause it to drop off by dissolving the metal underneath. Hydrofluoric acid also dissolves the magnetic iron oxide (Fe_3O_4) more readily than sulphuric acid or hydrochloric acid. 2—Hydrofluoric acid leaves a cleaner surface and does not penetrate into the castings as other acids seem to do. If castings which have been cleaned with sulphuric or muriatic acid are well washed and dried and afterward covered with metal or lacquer, it happens quite often that the latter are injured by excrescences starting from the metal.

In cleaning pipes for electrical conduits only the inner side is of importance; it must be perfectly smooth, so as not to injure the covered wires when they are pulled through. On the inside of metal pipes there are patches of melted slag. These can be removed with sulphuric or muriatic acid only by losing considerable metal. This slag, being a silicate, and the magnetic iron oxide, are dissolved directly by the hydrofluoric acid. Frequently a mixture of sulphuric and hydrofluoric acids is used for cleaning such pipe.

Cast steel can rarely be cleaned to advantage with hydrofluoric acid, because the loam used for molds is baked very hard and dissolves very slowly in hydrofluoric acid.

Castings and pipe are cleaned in the following manner: The acid is used in varying strengths, according to the condition of the material to be cleaned and the available time. One part 30 per cent hydrofluoric acid is mixed with 4 to 40 parts of water, which gives a solution containing 6.0 to 0.7 per cent hydrofluoric acid. The weaker acid is preferable if enough vessels are on hand to leave the castings in the acid pickle sufficiently long.

*Presented by K. F. Stahl before the Pittsburgh Section of the American Chemical Society, October 15th, 1914.

[1] Dammer, Molinari, Ed. Thorpe and Henri Moissan.

[2] It is generally known that hydrofluoric acid produces very painful inflammation if allowed to come in contact with the skin. The remedy usually recommended is washing with water and then with dilute ammonia water. This is effective only with weak acids; with stronger acids, particularly the 60 per cent, washing alone, even if done immediately, does not prevent inflammation, but if the washing is continued for about half an hour by holding the affected part under flowing water the bad effects will be prevented or at least materially reduced. Washing must, of course, begin at once after the acid has come in contact with the skin. Very dilute acid, i. e., up to 5 per cent, produces no ill effect by temporary contact with the skin.

[3] "Zeller die künstlichen Kohlen," Berlin, 1903.

[4] *Z. angew. Chemie*, 1903, p. 195.

[5] Dammer, 1, 371.

[6] *Z. angew. Chem.*, 1896, p. 225.

It requires about 12 hours to clean castings with 1 per cent acid. Comparatively more acid is required if stronger acid is used, but the time of cleaning is reduced.

Round or square wooden tanks without any protective covering are generally used. For economy in handling small castings they should be placed in a second wooden vessel perforated on the sides and slightly smaller than the first one. This has the advantage that the sand which falls off remains on the floor of the inner vessel, is lifted out with it and is thus removed from further action of the acid.

Heating accelerates the action of the acid bath, which can be used repeatedly if for every fresh batch of castings about 1/3 of the amount of acid originally used is added.

If the castings are to remain bright they should be washed with hot water as soon as they come out of the acid pickle, so that they dry off quickly; otherwise they can be washed with cold water. To the last wash water some milk of lime is usually added to prevent rusting.

Under the published uses of hydrofluoric acid, the one for etching glass was mentioned first; but it is very strange indeed that the use of strong hydrofluoric acid for *polishing cut glass*, which has been in practice for a number of years, is nowhere mentioned. It started about 18 years ago and is at present probably in use in all of the cut glass factories in this country.

The last operation in manufacturing cut glass is the polishing of the surfaces which have previously been cut into the glass. This was formerly done with oxide of iron or oxide of tin. As every plane had to be polished separately by skilled labor it was slow and expensive.

A finer polish is now obtained in the following manner: For vases and similar shapes, where the polish is required only on the outside, a wooden stopper is cemented in water-tight with paraffin or wax. Other surfaces which are not to be touched by the acid are also covered with asphaltum, wax or some similar substance. It is essential that all surfaces to be polished must be absolutely clean, and especially free of every trace of grease. To accomplish this, they are brushed with soda solution by girls who wear rubber gloves, then they are washed in clean water and after most of the water has dripped off they are dipped in the acid bath.

Generally a mixture of 1 part by weight of sulphuric acid, 66 degrees Baumé, with 3 parts 60 per cent hydrofluoric acid is employed. This mixture is in a lead vessel, large enough to submerge the largest pieces to be polished. It is placed directly in front of a ventilating tube, through which a ventilator creates a strong suction. This protects the polisher from the strong vapor given off by the acid mixture and he needs only a rubber apron and long rubber gloves for his protection. The perfectly clean and partly dried off pieces of glassware are held one at a time from ½ to 1 minute in the acid, and then immediately dipped into water.

By the action of the acid on the glass a thin crust is formed consisting of calcium fluoride, probably with some sulphate of lead and sodium or potassium fluoride. This is removed by brushing with water, after which the pieces are washed off in clean water and dipped again in the acid. The polish is usually complete after three dippings. Every piece is carefully inspected and defective spots are polished by hand; if the grinding was carefully done, this is rarely necessary.

Experiments undertaken to polish plate glass in the manner described did not produce satisfactory results. The surface obtained was glossy, but in place of being perfectly smooth, as in the case with cut glass, it was somewhat wavy. This difference may be caused by the materially different composition of the two glasses or by the apparently different manner of their production.

Buildings and monuments, particularly in industrial districts, obtain in course of time a dark color. This can be removed and the original color restored with hydrofluoric acid better and cheaper than in any other way; 15 per cent acid is generally used (30 per cent is diluted with the same volume of water). The workman wears rubber gloves and proceeds as follows: Two or three square feet of the surface are first moistened with a brush or sponge, then painted with the 15 per cent acid (for larger surfaces a whitewash brush can be used). After a minute or two the surface is scrubbed with a stiff brush and rinsed with water. The action on granite or sandstone is negligible; marble is acted on a little more and it is advisable to protect polished surfaces.

The glass roofs of greenhouses are cleaned in a similar manner. During the summer these are usually whitewashed to moderate the rays of the sun. This protective covering, on which also accumulates some dust and soot during the summer, has to be removed in the fall, as during the winter all the sunlight obtainable is needed. This is done by painting the surface of the glass with 15 per cent hydrofluoric acid, using a 6 to 8 inch whitewash brush fastened on a long pole. After a few minutes, when about 8 rows have been painted, the acid is washed off with water. In this manner the glass is made as clear and transparent as new, much better than was formerly possible with muriatic or oxalic acid.

If the houses are old and the panes of glass not absolutely tight, the glass in those houses where ferns, smilax and asparagus are raised should be cleaned before the plants are set out, because they sometimes get yellow spots from the fumes of the acid, which penetrate through the crevices even though the fumes are not perceptible to human beings.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

A Perpetual Calendar

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

I have examined with a good deal of interest the 4,000-year calendar printed in the SUPPLEMENT to the SCIENTIFIC AMERICAN on page 400, December 19th, 1914. I have done a good deal of work on calendars, and I have taken the trouble to study out this rather complex affair and find it is not reliable. I enclose a table of dates which I have looked up in this calendar, with their comparison with the correct dates. In this table there are twelve old-style dates, and Kennedy's calendar gives eleven of them wrong.

The change from old style to new style was made in England and her colonies in September, 1752, the days between September 2nd and 14th being omitted from this month; but there was no change in the succession of the days of the week. September 2nd, 1752, was Wednesday and September 14th in the same year was Thursday, being the following day. Kennedy's calendar gives both of these days as Thursday. Kennedy finds that Columbus discovered America on Monday, while history tells us it was Friday.

I have worked out a calendar very much simpler than this of Kennedy's, which covers the whole Christian era, and am sending you herewith a photographic reproduction of it. If the SCIENTIFIC AMERICAN SUPPLEMENT desires to publish this calendar I shall be glad to have it do so. The explanations given at the head of the calendar are all that is necessary to make it clear.

I note also in Kennedy's calendar that he takes no account of the fact that previous to 1662, when the English liturgy was revised, the extra day in February was inserted between February 23rd and 24th, which practice extends back to the time of Caesar. My calendar provides for these exceptional days.

W. J. SPILLMAN,

Washington, D. C.

KENNEDY'S CALENDAR.

1. Takes no account of place of intercalary day previous to 1662. (Between February 23rd and 24th).
2. Contains errors throughout. Example:

		Kennedy	True day.
October	12th, 192 (O.S.)	Wednesday	Thursday
October	12th, 292 (O.S.)	Monday	Wednesday
October	12th, 393 (O.S.)	Sunday	Tuesday
October	12th, 1092 (O.S.)	Monday	Tuesday
October	12th, 1292 (O.S.)	Friday	Sunday
October	11th, 1492 (O.S.)	Monday	Friday
January	10th, 372 (O.S.)	Sunday	Tuesday
January	10th, 572 (O.S.)	Wednesday	Sunday
January	10th, 872 (O.S.)	Sunday	Friday
January	10th, 972 (O.S.)	Wednesday	Wednesday
August	2nd, 1114 (O.S.)	Saturday	Sunday
September	2nd, 1752 (O.S.)	Thursday	Wednesday
September	14th, 1752 (O.S.)	Thursday	Thursday

The following letter received from Mr. Kennedy explains some of the discrepancies that have been found in the use of his tables:

"The table is absolutely correct, but there are two slight errors in the examples given, which require correction.

1. "Example 1," your proof-reader has inverted the figures "89" making it read "98."

2. "Example 3," is my oversight. "In century table opposite O" should read, opposite "1", for the beginning of the century was January 1st, 1. Then follow this by "which is *6*," added to 1 gives Saturday, instead of "Friday."

The Christian Era began on *Saturday* instead of "Friday."

None of the readers of the SUPPLEMENT seems to have detected this, and I am interested in having these little errors corrected.

S. F. KENNEDY.

PERPETUAL CALENDAR

To find the day of the week of any date: find the year; proceed thence up the column to the month; the line of week days opposite applies to that month. Example: Jan. 5, 1915; the year 1915 occurs in the last column (at extreme right). In this column the month of January occurs opposite the line of week days beginning with Friday. Hence Jan. 1, 1915 is Friday, and Jan. 5 is Tuesday.

Leap years occupy 2 columns. For dates in Jan. and Feb., leap years are to be regarded as belonging to the 1st, and for later months the 2nd, of these two columns.

The table of years covers 4 centuries. Years in other centuries are brought within the limits of the table by adding or subtracting any exact multiple of 400 yrs. Thus the year 1492 would occupy the same place as the year 1892; the year 412 the same place as 1612, &c. Old Style dates must first be converted to New Style (see conversion table).

May	Jan Oct	Apr Jul	Sep Dec	Jun	Feb Mar Nov	Aug	Sun	Mon	Tue	Wed	Thu	Fri	Sat	May	Jan Oct	Apr Jul	Sep Dec	Jun	Feb Mar Nov	Aug
Aug	May	Jan Oct	Apr Jul	Sep Dec	Jun	Feb Mar Nov	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Aug	May	Jan Oct	Apr Jul	Sep Dec	Jun	Feb Mar Nov
Feb Mar Nov	Aug	May	Jan Oct	Apr Jul	Sep Dec	Jun	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Feb Mar Nov	Aug	May	Jan Oct	Apr Jul	Sep Dec	Jun
Jun	Feb Mar Nov	Aug	May	Jan Oct	Apr Jul	Sep Dec	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Jun	Feb Mar Nov	Aug	May	Jan Oct	Apr Jul	Sep Dec
Sep Dec	Jun	Feb Mar Nov	Aug	May	Jan Oct	Apr Jul	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Sep Dec	Jun	Feb Mar Nov	Aug	May	Jan Oct	Apr Jul
Apr Jul	Sep Dec	Jun	Feb Mar Nov	Aug	May	Jan Oct	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Apr Jul	Sep Dec	Jun	Feb Mar Nov	Aug	May	Jan Oct
Jan Oct	Apr Jul	Sep Dec	Jun	Feb Mar Nov	* Aug	May	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Jan Oct	Apr Jul	Sep Dec	Jun	Feb Mar Nov	Aug	May

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

16	00	1601	1602	1603	16	04	1803	18	04	1805	1806	1807	18
1605	1606	1607	16	08	1609	1610	08	1809	1810	1811	18	12	1813
1611	16	12	1613	1614	1615	16	1814	1815	18	16	1817	1818	1819
16	1617	1618	1619	16	20	1621	18	20	1821	1822	1823	18	24
1622	1623	16	24	1625	1626	1627	1825	1826	1827	18	28	1829	1830
16	28	1629	1630	1631	16	32	1831	18	32	1833	1834	1835	18
1633	1634	1635	16	36	1637	1638	36	1837	1838	1839	18	40	1841
1639	16	40	1641	1642	1643	16	1842	1843	18	44	1845	1846	1847
44	1645	1646	1647	16	48	1649	18	48	1849	1850	1851	18	52
1650	1651	16	52	1653	1654	1655	1853	1854	1855	18	56	1857	1858
16	56	1657	1658	1659	16	60	1859	18	60	1861	1862	1863	18
1661	1662	1663	16	64	1665	1666	64	1865	1866	1867	18	68	1869
1667	16	68	1669	1670	1671	16	1870	1871	18	72	1873	1874	1875
72	1673	1674	1675	16	76	1677	18	76	1877	1878	1879	18	80
1678	1679	16	80	1681	1682	1683	1881	1882	1883	18	84	1885	1886
16	84	1685	1686	1687	16	88	1887	18	88	1889	1890	1891	18
1689	1690	1691	16	92	1693	1694	92	1893	1894	1895	18	96	1897
1695	16	96	1697	1698	1699	1700	1898	1899	1900	1901	1902	1903	19
1701	1702	1703	17	04	1705	1706	04	1905	1906	1907	19	08	1909
1707	17	08	1709	1710	1711	17	1910	1911	19	12	1913	1914	1915
12	1713	1714	1715	17	16	1717	19	16	1917	1918	1919	19	20
1718	1719	17	20	1721	1722	1723	1921	1922	1923	19	24	1925	1926
17	24	1725	1726	1727	17	28	1927	19	28	1929	1930	1931	19
1729	1730	1731	17	32	1733	1734	32	1933	1934	1935	19	36	1937
1735	17	36	1737	1738	1739	17	1938	1939	19	40	1941	1942	1943
40	1741	1742	1743	17	44	1745	19	44	1945	1946	1947	19	48
1746	1747	17	48	1749	1750	1751	1949	1950	1951	19	52	1953	1954
17	52	1753	1754	1755	17	56	1955	19	56	1957	1958	1959	19
1757	1758	1759	17	60	1761	1762	60	1961	1962	1963	19	64	1965
1763	17	64	1765	1766	1767	17	1966	1967	19	68	1969	1970	1971
68	1769	1770	1771	17	72	1773	19	72	1973	1974	1975	19	76
1774	1775	17	76	1777	1778	1779	1977	1978	1979	19	80	1981	1982
17	80	1781	1782	1783	17	84	1983	19	84	1985	1986	1987	19
1785	1786	1787	17	88	1789	1790	88	1989	1990	1991	19	92	1993
1791	17	92	1793	1794	1795	17	1994	1995	19	96	1997	1998	1999
96	1797	1798	1799	1800	1801	1802	20	00	2001	2002	2003	20	04

CONVERSION TABLE.

To convert Old Style dates to New Style:

From		To		
Jan. 1,	1,	Feb. 23,	100,	Subtract 2 das
Feb. 24,	100,	"	200,	" 1 day
"	200,	"	300,	No change
"	300,	"	500,	Add 1 day
"	500,	"	600,	" 2 das
"	600,	"	700,	" 3 "
"	700,	"	900,	" 4 "
"	900,	"	1000,	" 5 "
"	1000,	"	1100,	" 6 "
"	1100,	"	1300,	" 7 "
"	1300,	"	1400,	" 8 "
"	1400,	"	1500,	" 9 "
"	1500,	Feb. 28,	1700,	" 10 "
Feb. 29,	1700,	"	1800,	" 11 "
"	1800,	"	1900,	" 12 "
"	1900,	"	2100,	" 13 "

If the date to be converted falls on Feb. 24 to 28 in a leap year previous to 1662, add a day to the result obtained above.

Old Style dates.	Same date New Style.
Feb. 26, 1324; 26+8+1=35; 35−29	=Mar. 6, 1324.
" 27, 372; 27+1+1=29	=Feb. 29, 372.
Oct. 12, 1492; 12+9 =21	=Oct. 21, 1492.

The Gas from Blast Furnaces—IV*

Its Cleaning and Utilization

By J. E. Johnson, Jr.

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2042, Page 127, February 20, 1915

METHODS OF DETERMINING THE AMOUNT OF DUST IN BLAST-FURNACE GAS.

A METHOD employed with good results in Europe for determining the amount of dust in the gas consists in drawing a definite quantity of the blast-furnace gas to be tested through a filter, which is weighed in a dry condition before and after the test. The apparatus for determining the amount of dust consists of a glass tube drawn out at one end and fitted at the other with a ground-glass cover which is also drawn out to a thin tube. This cover facilitates the placing of the filtering material in the tube, and during the test the cove

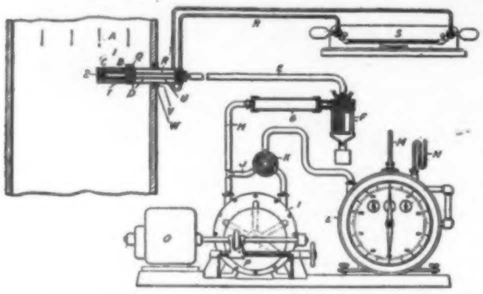


Fig. 30.—The Brown dust, moisture, and volume determinator.

is fastened to the tube by means of wire. Before the test, the glass tube, filled with suitable filtering material is placed in a drying furnace and heated at a temperature of 105 deg. Cent. until its weight is constant, which usually requires from 1 to 2 hours. The drying furnace is arranged so that several tubes can be dried simultaneously.

During the drying process air is drawn through the tubes after having previously been thoroughly dried by passing through bottles containing calcium chloride and concentrated sulphuric acid. During the drying process the tubes are weighed until no further increase in weight is observed.

In making the test, the weighed tube containing its filtering material is inserted into the gas main, a rubber stopper keeping the test-hole tight. The upper end of the tube is connected with a gas meter, which in turn is connected with a barrel filled with water. The water is allowed to flow out of the barrel and in so doing creates the necessary suction to draw the gas through the filtering tube and through the gas meter. When the necessary amount of gas has been withdrawn the tube is again dried and weighed. The increase in weight decrease the amount of dust in the quantity of gas tested.

BROWN DUST, MOISTURE, AND VOLUME DETERMINATOR FOR BLAST-FURNACE AND OTHER GASES.

This apparatus has been devised in order to accurately determine the amount of dust and moisture contained in blast-furnace gas, as well as the volume of the gas, and is used with considerable success.

Referring to the accompanying drawing, Fig. 30, *A* is a gas main conveying the gas to be tested. *B* is an aperture in the small pipe through which samples of the gas are drawn. *C* is a filtering medium within which the solid constituents of the gas are deposited. *D* is a conduit leading to the exterior of the gas main through which the filtered gas is conducted. *E* represents a flexible connection to a surface condenser, *F*. *G* represents a receptacle for some chemical, such as calcium chloride, which can be used for the purpose of taking out the moisture contained in the sample. *H* is a conduit from this moisture-removing receptacle to the rotary air pump, *I*, or through the by-pass *J* to the three-way valve *K* and thence to the gas meter *L*, where the volume of the sample is determined, together with its temperature and pressure; these latter by means of the thermometer *M* and the U-tube *N*, respectively. An electric motor, *O*, is used to operate the pump *I* through the variable-speed drive *P*.

An indication of the velocity of gas or gases in conduit *A* is transmitted through aperture *Q* in the sample pipe and conduit *R* to horizontal pressure gage *S*; also an indication of the velocity of gas or gases after passing aperture *B*, is transmitted from aperture *T* through conduit *U* to horizontal pressure gage *S*. It is evident that changes of the velocity of the gas or gases in aperture *B* of sample pipe, produced by the suction of pump *I* or by pressure in gas main *A*, are indicated, and can be accurately controlled and made equal to the velocity of the gas or gases in conduit *A*, the gas main, such indicator being the oil piston shown in glass tube forming a part of the velocity gage *S*.

The method of operating this apparatus is as follows: The dry weights of the filtering medium *C*, of the receptacle *G*, containing the calcium chloride, and of the measuring flask attached to surface condenser *F*, are very carefully determined. They are then inserted in the apparatus, and the sample pipe is then inserted in the gas main, a tight connection being made between flange *W* and bushing *V*. The meter reading is noted. At the same time that the sample pipe is inserted in the gas main *A*, the time is noted, and the rotary pump *I* started. The speed is then so regulated that the oil piston in the horizontal pressure gage *S* is maintained in equilibrium. This indicates that the velocity in aperture *B* is exactly equal to the velocity in gas main *A*, this condition having been determined by a measured amount of gas in gas main *A*, and the proper proportioning of aperture and conduits in the sample pipe during the calibration tests. This condition is maintained for an definite length of time and the sample pipe is then withdrawn from gas main *A*. The meter reading, multiplied by the ratio of area of aperture *B* to area of gas main *A*, gives the total amount of gas passing through gas main *A* in the elapsed time. The difference between the dry weight of the filtering medium *C*, before and after the test, divided by the number of cubic units shown by the meter, gives the weight of dust per cubic unit. The moisture per cubic unit of gas is found in a similar manner from the sum of the weights of the water in drying receptacle *G*, the water caught in the measuring flask attached to surface condenser *F*, and the weight of water retained in the filtering medium *C*.

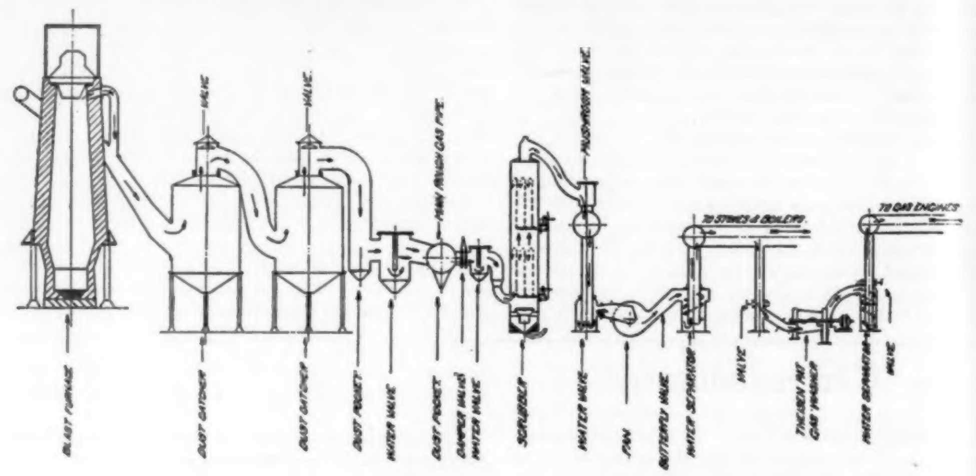


Fig. 31.—The course of the gas through the cleaning process to stoves, boilers, and engines.

Figs. 31 to 34 are reproduced from Mr. Diehl's paper as showing approved types of construction. The text of Mr. Diehl's concerns itself principally with operation and will be quoted in dealing with that subject.

In addition to the processes so clearly described by Mr. Forbes, there are various others designed to remove the dust from the gas in the dry state, but as these have had no extensive application for the blast furnace process, they may be omitted here.

Even since the time of Mr. Forbes' paper there has been an extensive development in Europe of the Halberger-Beth process of which there are now almost thirty plants in use in Europe and the number has been rapidly increasing. American furnacemen have been slow to take up this process and have acted in this matter along the same line as in many other cases; where an apparatus requires careful supervision or where its maintenance charges are high, operating economies secured by its use are disregarded. The same has been true in regard to the gas engine, by-product coke-oven and many other kinds of apparatus.

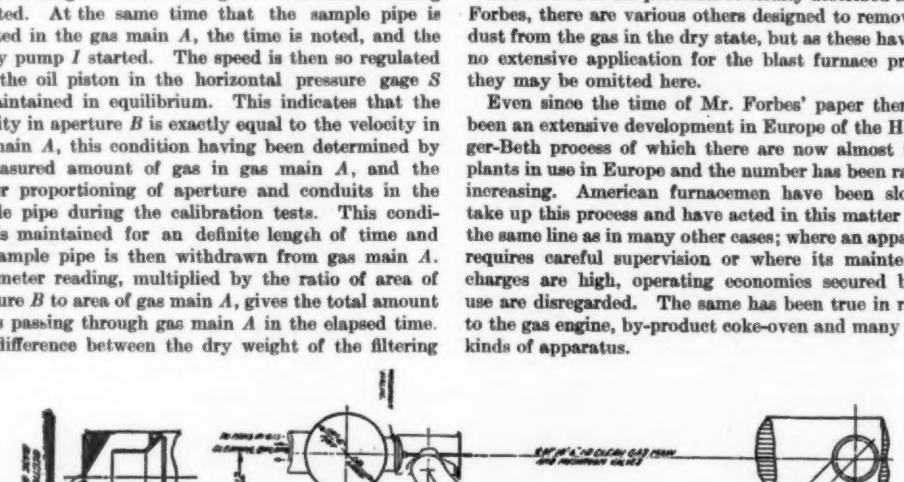


Fig. 32.—Section through the scrubbers, showing method and apparatus for primary cleaning. The cut-off valves are on the side and driven from a vertical shaft.

* Reproduced from *Metallurgical and Chemical Engineering*.

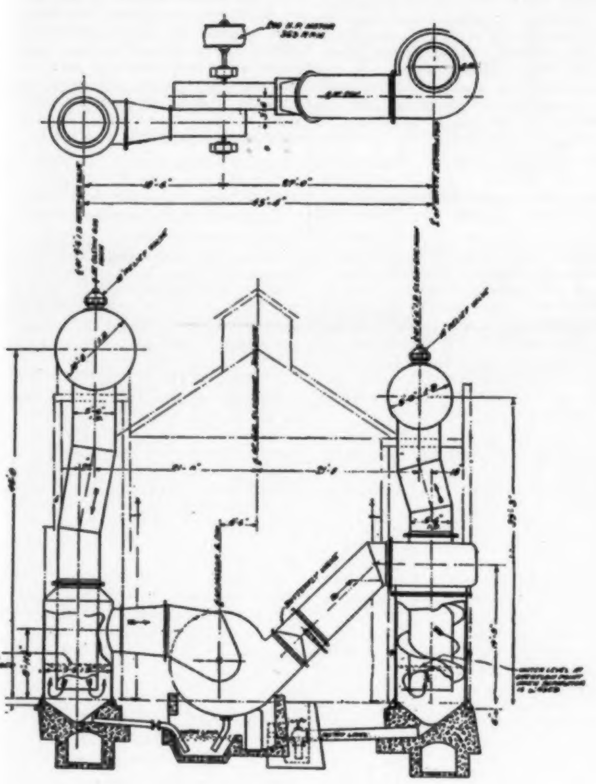


Fig. 33.—Section through fans, and method of passing gas through seals and separators.

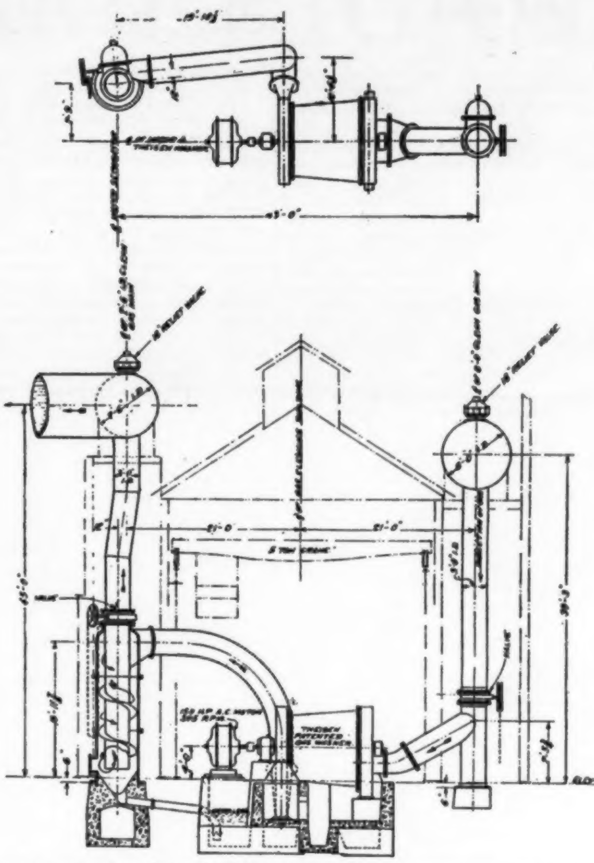


Fig. 34.—Section through Thiesen's seals and separators, showing course taken by the gas.

This attitude is one often censured not only by foreigners, but also by Americans who do not consider all the aspects of such problems, particularly the financial one. The relative cheapness of capital and supervision and the costliness of raw materials in Europe as contrasted with the high cost of capital in America and the low cost of raw material constitute in no small measure a justification for the American attitude.

There is reason to hope that a process may soon be developed superior to either the wet processes or bag filtration plant and less complicated and difficult of maintenance. I refer to the Cottrell process for the electrical precipitation of the dust by a high-tension direct current passing through the gas column. This process has been developed to complete success in several lines of industry but its sponsors have hesitated to attack the blast furnace problem on account of its size and the complexity of the conditions. If this process shall ever be worked out to a commercial success it will furnish gas absolutely clean with no loss of temperature and with no increase in its moisture. These are the ideal conditions for the use of furnace gas for combustion purposes. For the gas engine it must, in any event in present practice, be cooled about to atmospheric temperature and this, of course, can easily be done after the gas is removed by a direct spray. Perhaps the time might even come if hot cleaned gas were available, that the gas engine could be adapted to its use and thereby further increase its economy.

In conclusion it may be said that it is impossible at the present time to write a history of gas cleaning The whole development of the subject in this country covers barely 10 years in all and nine-tenths of it has been in the last 7 or 8 years. The advantages have become manifest and all furnacemen have sought *a* way rather than *the* way to clean the gas, and undoubtedly they were right in this course for the plants installed early, even though not the last word of perfection in the subject, will have paid for themselves in bettered operating conditions before the much-to-be-desired best method is developed. It is possible, therefore, with this rapid development in progress, to give only an outline of the subject and to state briefly the principles which underly its application. To do this has been the attempt of the present article.

Mathematics and Artillery Science

At a recent meeting of the Mathematical Association, in London, Sir George Greenhill made a remarkable address in which he brought out strongly the relations of science to war, and particularly emphasized the almost hopeless position of a country that is supinely content with the systems of a century ago. America might learn a useful lesson from the following abstract of the address derived from the London *Times:*

Sir George Greenhill said that less than six months ago the artillery officer would have said there was no such thing as mathematics in artillery science. But that outlook was now ancient history. This was a mathematical war. Drawing upon his experience as a professor of artillery theory for instances where science could prove itself useful on service, he explained how particulars of the enemy's guns could be deduced from fragments of the wall of a shell and photographic pictures. From a fragment they could determine whether a shell came from one of the 42-centimeter howitzers, the very existence of which still appeared in doubt. Dealing with the calculation for ascertaining how far men should stand from a gun to avoid the danger of permanent deafness, he said they need not fear to stand twelve yards behind the 42-centimeter howitzer; and so the story was discounted of the firing party taking cover 100 to 200 meters away when this howitzer was fired. An application of the theory of the conduction of heat would have reassured our men that life in the trenches would not be too cold, or would at least be warmer than in the frost above, provided only the floor could be drained dry under foot. It had also to be borne in mind that the trench gave better cover than a tent.

Five years ago he had an invitation to Berlin, to visit the Military Technical Academy there. It was a magnificent institution, such as we could not afford, so our rulers assured us. Prof. Cranz showed how in his department no money was spared in recent equipment, including a bomb-proof range available for artillery fire and yet in the heart of a big city. There were plenty of outdoor artillery ranges also to visit, where instructive work was in progress. The Perry system of education was adopted in Berlin. After a lecture on wireless telegraphy the class was set to work, as he saw, in making the antennæ which had played such an important part in the war. Sixty officers were under instruction at a time for a course of three years, and he was assured their zeal was admirable. It was considered such bad form not to give the best in return for the honor and glory of the Fatherland. But our Regular was apathetic by comparison. We must put our trust in the junior ranks to push old Apathy from his stool and carry us through this war.

MOURNFUL CONTRAST AT WOOLWICH.

It was a mournful contrast to revert to Woolwich, shabby and undisciplined. There they had been evicted from their proper home, and were told to found a new artillery college with the choice of a cellar under some stables, or a kitchen and scullery and bare walls in a deserted hospital, there to organize victory, and at no expense. With the courage of an Austrian general compelled to maintain his muzzle-loading musket a match for the Prussian needle-gun, the Military Director assured them that there was nothing superior to be found at Greenwich, in the Naval College there lodged in the old Palace. Such dismal, penurious surroundings had a disastrous effect on the *genius loci*, and they never really recovered from a downhearted spirit not calculated for victory. Our military science was under the rule of Thumb, the official genius. His fumbling method was considered a match for disciplined theory.

We saw already how the cost had been well laid out in this war of the Berlin Military Technical Academy, the German jumping off with a lead he was able to keep so far. The finished article of the academy was employed in the dissemination of true theory and in the scientific direction of warlike preparation as at Krupps. Assuming everything for the best for the Allies, and if we lived to go in again at Antwerp, an interesting match would be watched between our artillery science and the German, to see how long it would take us to get the other side out, compared with our own innings and the time we kept our wicket up. No long-range fire, he had been assured, was ever going to be of any use again, involving theoretical calculation. The word was, "Gallop up close, to 400 yards, and let them have it."

The country was furious at the way our poor fellows were pounded mercilessly at the start by long range accurate howitzer fire, with no protection from our own side. King George's stirring appeal, "Wake up, England," was intercepted by our rulers, and it was England the unready again when our senior lethargy bumped into the titanic energy of the German Empire.

Light, Power and Irrigation in California

Hydro-electric plants have reached a high state o development in California. At present there are 110 reservoirs with a storage capacity estimated at 235,-780,000,000 gallons, and the plants served produce a million horse-power in electric current which is used for light, and for power not only for running car lines but in factories as well. In many cases the current has to be carried great distances from the generating plants to the place where it is used, and as high as 150,000 volts are carried on some of the lines. One most useful feature that has been developed in planning some of the California plants is the utilization of the water, after it has done its work in producing electricity, for irrigation; and where this cannot be done directly it has in some cases been found feasible to use electric power to pump water for irrigating what would otherwise be unproductive lands.

NEW BOOKS, ETC.

SMITHSONIAN PHYSICAL TABLES. Sixth Revised Edition. Prepared by Frederick E. Fowle, Aid Smithsonian Astrophysical Observatory. Washington: The Smithsonian Institution, 1914. Price, $2.

We greet with pleasure a new edition of this invaluable collection of tables. The meteorological tables first issued by the Institution in 1852, and primarily compiled to meet the needs of meteorological observers, received such a cordial acceptance at the hands of physicists in general that the volume was followed by three others, dealing respectively with geographical, physical, and mathematical tables. Each of these books presents independently the latest knowledge in its particular field, and together they form a homogeneous series. The fifth and sixth revisions of the physical tables gave opportunity for the consideration and inclusion of much new data, and many governmental and other authorities have contributed to the improvement of the work. The tables have been very carefully rechecked, typographical errors eliminated, certain tables amplified, and not a few entirely new tables added. To Roentgen rays and to radio-activity entirely adequate space has been accorded. All the usual compilations presenting logarithms, strength of materials, compressibility of gases, liquids and solids, sound velocities, and terrestrial magnetism, are of course to be found, and with these a wealth of calculation relating to subjects in less frequent use, such as musical scales, aerodynamics, light-efficiencies, explosives, and magneto-optic rotation. Every physicist should hold this as one of the most useful volumes of his working library.

THE YOUNG MAN'S CHANCES IN SOUTH AND CENTRAL AMERICA. A Study of Opportunity. By William A. Reid. Washington: Southern Commercial Congress, 1914. 12mo.; 173 pp.

A most timely and vital discussion is this study of present-day opportunity in the logical field of our future activities. It is endorsed in a few words of sincere appreciation by John Barrett, director general of the Pan-American Union, with whose staff the author has held an important position for some years. There has been a dearth of just such intimate information as is conveyed by his thoughtful papers, and our young men of worthy ambitions to whom the papers are addressed may learn from them not only of Latin-American opportunities, but also—what is of almost equal importance—of the pitfalls to be avoided. It is pointed out that to take advantage of Latin-American needs it is not always necessary to reside in South America. Periodical travel and a careful study of requirements will often serve quite as well. Mr. Reid discusses positions and openings in agricultural, engineering, and commercial enterprises, presents factors in development as recognized by competent authorities, tells us what the Latins say of themselves, and gives the names of many firms employing North Americans. To youthful, strong and progressive spirits whose eyes are turned southward this series of studies may be followed to great advantage.

STUDIES OF TREES. By J. J. Levison, Forester to the Department of Parks, Brooklyn, N. Y. 8vo.; x, 253 pp.; 155 text figures and half-tone plates. New York: John Wiley & Sons, 1914. Price, $1.60.

This book is intended for the use of the teacher of nature studies and the student of elementary forestry. Although there are several other excellent popular works which deal with this same general theme, Mr. Levison's book is much needed and will be eagerly welcomed by many who are interested in the identification, structure, habits, and uses of our most common trees. The book is divided into nine chapters dealing with identification of trees; their nature, habits and growth; insects and diseases which attack them; their grouping and planting; the pruning and care of trees; the characteristics of the commercial woods; the care of the wood lot, and a general consideration of the study of forestry in its many aspects. In the identification of trees, for instance, stress is laid on some one character that stands out prominently and distinguishes the tree at a glance from all others and in all seasons of the year. Possible confusion with other trees of similar appearance is prevented through careful comparisons which bring out the peculiarities of each species. In these respects the book is unique and is different from any other now available. The discussion of the planting and proper care of trees and of the fundamental principles of forestry, based upon the author's experience of over eight years in the Department of Parks, Brooklyn, N. Y., and in the United States Forest Service, is thoroughly up-to-date and reliable, and will be found suggestive and usable in the highest degree. It is especially recommended as meeting the needs of farmers and others having the care of estates and woodlands, and of students in short or elementary courses in agriculture and forestry. The treatment is concise, systematic and free from an undue use of botanical terms. The author's aim throughout is to give only the salient points and to so present his text that the reader is enabled to reach at a glance, the main features of the subject under discussion. While this book is intended to offer a general and elementary *résumé* of the whole subject of tree studies and will probably be read chiefly by teachers interested in nature work in schools, nevertheless its readable style, choice and arrangement of subject and emphasis laid upon accuracy, cannot fail to commend the publication to trained foresters and others.

ECONOMICS OF EFFICIENCY. By Norris A. Brisco, A.M., Ph.D. New York: The Macmillan Company, 1914. 12mo.; 385 pp. Price, $1.50 net.

The literature of the new efficiency grows by leaps and bounds. Defining the aim of the new era as the elimination of waste, Prof. Brisco sets forth the latest knowledge pertaining to the reduction of expenditure is energy, time and materials. The underlying principles are exposed, their importance demonstrated, and their operation simply explained for the benefit of the business man. Organization and coordination in the industrial world is considered from different standpoints. Methods of handling men are debated upon, and the hiring of labor—a science too frequently neglected—is the subject of some sensible suggestions. The policy of receiving applicants only when a vacancy occurs is strongly condemned. Habits, fatigue, training and environment, all come within the scope of the work. The chapter on wages and wage systems will be enlightening to many employers hitherto content to jog along the beaten track. Test questions and bibliographies give the work a text-book value.

ELECTRIC-LIGHT FITTING. A Treatise on Wiring for Lighting, Heating and Other Domestic Uses to which Electricity can be Applied, and the Laying Down of Small Private Installations. By S. C. Batstone, A.M.I.E.E. New York: The Macmillan Company, 1914. 12mo.; 317 pp.; 238 illustrations. Price, $1.50 net.

Here is one of the most attractive presentations of the subject we have seen. The laws and the units of measurement are very clearly explained by means of simple analogies. The various accessories of lighting are before us in the clear line drawings of the book, and their aid is continued into the layout of circuits, house wiring, and the equipment of complete private plants. The text is concluded with the rules laid down by the Institution of Electrical Engineers, which were framed with a view to satisfactory results in the use of low-pressure energy not exceeding 250 volts.

RESISTANCE OF MATERIALS. By S. E. Slocum, B.E., Ph.D. New York: Ginn & Co., 1914. 8vo.; 210 pp.; illustrated. Price, $2.

A noticeable feature of this text is the employment of the principle of moments to the exclusion of calculus processes. This, of course, means simplicity in exposition. The necessity to await the completion of a course in the calculus is obviated, and the student is enabled to enter upon the mechanism of materials at an early stage. In trade schools which omit the calculus this advantage will be at once apparent. Principles and practice have been so skillfully interwoven that their knowledge is simultaneously acquired. Engineering applications supplement the text, and answers to problems are bound with the book.

THE WAR AND AMERICA. By Hugo Munsterberg. New York and London: D. Appleton & Co., 1914. 12mo.; 210 pp. Price, $1 net.

Anything from the pen of Hugo Munsterberg is illuminating and of great interest; and although many of the American readers of this work will not subscribe to some of its sentiments, they will find it well worthy of purchase and careful reading. The work discusses the essential factors and issues in the European war and their meaning and import for America. The author believes that the hour for an impersonal account of the war has certainly not yet come and may not come for a long while; and that what our time can contribute is the reflection of the great war in the minds of individuals. Since Prof. Munsterberg's life has brought him into close contact with much which is essential to this war, he believes that this study may help toward a better understanding of facts and feelings which are easily misunderstood in America. "Whatever more the struggle may bring," says the author, "refers to outer events, to the harvest of the guns, to victory or defeat. It cannot change the issues with which these pages have to do. They do not speak of soldiers and strategy and the chances of the battlefield; they speak of right and wrong, they speak of eternal values." The general drift of the book may be determined from the heading of the chapters, the first of which is entitled "The Aggressor." Following this are chapters on "The Anti-German Sentiment," "The German-American," "Threatened Provinces," "The English," "Philosophers," "The Russians," "The German Policy," "The Kaiser," "The Silent Voices," "The Americans," and "The Morals of the War."

THE WAR IN EUROPE. By Albert Bushnell Hart, Professor of the Science of Government, Harvard University. New York and London: D. Appleton & Co., 1914. 12mo.; 254 pp. Price, $1 net.

Prof. Hart has written this book in the belief that other Americans besides himself might be interested in a brief but systematic statement of the resources, aims and difficulties of the European powers; the manner in which they became involved in the war; and the probable result of the struggle to America and to the rest of the world. The work is based on personal acquaintance with all the countries at war except Russia and the Scandinavian countries. Much of the matter results from studies begun 30 years ago in the universities of Freiburg and Berlin and the Ecole des Sciences Politiques in Paris. The book is intended to be a study of facts, conditions and probable results, and is not intended as an argument. The notable chapters in this volume are those on "The Significance of the European War," "The Six Great Powers," "International Rivalries and Strains," two chapters describing the war in the Balkans and how that war became European, "The Psychology of the War," and the effect of the war on the United States and its probable outcome.

THE WELLCOME PHOTOGRAPHIC EXPOSURE RECORD AND DIARY. U.S.A. Edition. New York: Burroughs Wellcome & Co., 1914. 281 pp.; illustrated. Price, 50 cents.

The Wellcome Diary for 1915 comes to us in the same attractive makeup that has become familiar to us. As a reference and note book for the photographer it has many features to commend it. The sliding-scale exposure calculator attached to the inside back cover is, of course, in evidence as usual. Timely hints and useful tables abound. There has even been found room for a frontispiece in color—a blue hyacinth—which is an exceptionally charming bit of work.

MOTOR-CYCLE PRINCIPLES AND THE LIGHT CAR. By Roger B. Whitman. New York: D. Appleton & Co., 1914. 12mo.; 281 pp.; illustrated. Price, $1.50 net.

Many readers have a grateful recollection of Mr. Whitman's "Motor Car Principles." In this later volume he takes up the timely subject of the motor-cycle and the light car, stating very clearly the essential differences between the latter and the standard type of automobile, and analyzing in detail a representative light car. Motor-cycle engines and their accessories are very thoroughly covered, with gearing practice, cooling, lubrication, carburetion and ignition. Construction details of the different types are not gone into, the author taking it for granted that, once principles are well understood, their application to variant types is an easy matter. The chapters on care, maintenance, and the causes of trouble are illuminating and full of practical help, and the work is worthy of warm appreciation from any interested in either of the motor vehicles with which it deals.

OPTIC PROJECTION. By Simon Henry Gage and Henry Phelps Gage, Ph.D., Ithaca, N. Y.: Comstock Publishing Company, 1914. 8vo.; 731 pp.; illustrated with plates and with more than 400 text-figures. Price, $3.

Here we have a science that has lately made such strides in popular appeal, and which promises so much in the educational field by its graphic impartation of knowledge to a large number of persons at one time, that such a broad and yet explicit work as "Optic Projection" should immediately find a wide circle of students. All kinds of projection apparatus and all methods of lighting are presented. The magic lantern, opaque projection, and the preparation of slides are most fully dealt with. The projection microscope, drawing and photography by means of lantern and camera, and moving pictures, are all explained by the profusely illustrated text. There are chapters on the room and the screen, electric currents and their measurements, the optics of projection, and the use of projection in physics. In a word, apparatus of various forms and using various methods of lighting, are considered from the standpoints of the operator, the manufacturer, and the student. Certain faults in present-day manufacturing practice are pointed out, and remedies suggested.

FUNDAMENTALS OF PLANT BREEDING. By John M. Coulter, Ph.D. New York: D. Appleton & Co., 1914. 12mo.; 347 pp.; illustrated. Price, $1.50 net.

The increase of population in excess of food production creates a problem that becomes more and more insistent with the passing of the years. Science is gradually acquiring a knowledge that makes possible a revolution in plant culture. The author of the volume in hand presents and summarizes this knowledge in intelligible language. From theories of natural selection and mutation he passes to a consideration of reproduction and culture, reviewing recent work in genetics and explaining the role of hybrids. The securing of drouth-resistance and of disease-resistance is studied. Forestry and its methods is adequately dealt with, and there is a short account of what the Government is doing for agriculture in general. The soil in its relation to plants is a most important consideration, and this is reserved for the final chapter. Altogether the work is very timely and acceptable, and presents its subject in a capable manner and from a positive point of view.

AUTOMATIC TELEPHONY. A Comprehensive Treatise on Automatic and Semi-Automatic Systems. By Arthur Bessey Smith, E.E., and Wilson Lee Campbell, E.E. New York: McGraw-Hill Book Company, Inc., 1914. 8vo.; 407 pp.; illustrated. Price, $4 net.

As a subject that is receiving much attention, and toward which much experimental work is being directed, automatic telephony is rapidly building up a literature of its own. Automatic or semi-automatic systems have already been adopted by many governments and as a natural consequence there is an increased demand among telephone engineers for a wider and deeper knowledge of its principles and practice. The treatise in hand endeavors to meet this demand by describing typical circuits and apparatus for the more important systems now in use. The subscribers' station equipment for a two-wire system, measured service equipment, and automatic traffic distributor installation, are chapter-headings that indicate the comprehensive nature of the work. The systems of the larger American companies are clearly described, and a final chapter on development studies will prove especially useful and suggestive to students. The many diagrams and inserts lend clarity to what is a somewhat intricate subject

LEKTRIK LIGHTING CONNECTIONS. With Introductory and Explanatory Notes by W. Perren Maycock, M.I.E.E. London, England: A. P. Lundberg & Sons. Price, 7d.

"Lektrik Lighting Connections" is a vest-pocket booklet describing modern tumbler-switch controls. Numerous diagrams and concise explanations abound. Single-switch control is designated as a survival of the "bad old days of gas," and combination installments are urged.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, FEBRUARY 27, 1915

Charles Allen Munn, President
Frederick Converse Beach, Secretary
Orson D. Munn, Treasurer

All at 361 Broadway, New York

Entered at the Post Office of New York, N. Y
As Second Class Matter

The Scientific American Publications

Scientific American Supplement (established 1876) per year	. . .	$5.00
Scientific American (est. 1845) "	. . . .	3.00
American Homes and Gardens "	. . . .	3.00

The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.

Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, N. Y.

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Table of Contents